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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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The B.C.I.R.A. Scottish Laboratories are:—
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Forthcoming Events.

MARCH 21.

Sheffield Metallurgical Association:—Ordinary meeting. "Recent Developments in High-Temperature Refractories," Paper by C. Presswood.

MARCH 22.

Institution of Welding Engineers (Manchester Section):—Ordinary meeting. "Relationship and Applications of Various Welding Methods," Paper by P. L. Roberts.

MARCH 28.

Sheffield Metallurgical Association:—Ordinary meeting. "The Application of the Molten Cyanide Bath to the Heat-Treatment of Metals," Paper by W. Nelson.

Institute of British Foundrymen.

MARCH 18.

Scottish Branch (Falkirk Section):—Ordinary meeting. "The Sand Question in regard to Light-Casting Production," Paper by F. Hudson.

MARCH 23.

Birmingham, Coventry and West Midlands Branch:—Ordinary meeting. "The Welding of Ferrous and Non-Ferrous Metals," Paper by W. C. Freeman.

MARCH 25.

Scottish Branch:—Annual general meeting at Glasgow.

Newcastle-upon-Tyne and District Branch:—Ordinary meeting. "The Preparation of Moulding Sands," Paper by J. B. Corrie.

Porosity in Castings.—I.

An engineering contemporary discusses the way in which the question of porosity is forcing itself on engineers as a consequence of the realisation of the fact that all material is more or less porous. The author argues that the task of the founder is to produce castings with a minimum of porosity and the duty of the designer to make allowance for the influence of porosity on mechanical strength. He also goes on to suggest that there is little hope of reducing the high factor of safety in casting design until the foundry can solve its twin problems of occluded gases and porous areas due to shrinkage, and he affirms that the engineer will demand that foundry processes in future be put on such a basis that there is no possibility of failure and that castings will have to be obtainable to specification.

In speaking of porosity several varieties have to be borne in mind. There is the porosity due to blow-holes, arising from entrapped air or gases and that due to shrinkage and contraction. These are liable to occur in all castings. In cast iron there is the added liability due to the existence of graphite cavities, through which, under certain circumstances, leakage can take place. This is, of course, the greater, the larger the cavities and the wider the flakes, and the greater the quantity of graphite present.

There is also a sense in which all metals are porous, particularly at elevated temperatures, to gas and to some fluids. There is no reason to suppose that cast iron is more liable to trouble in this connection than any other ferrous metal. This might be termed micro-porosity, and even the perfect casting is likely to be micro-porous, although anything which increases the density will decrease this micro-porosity.

So far as ordinary blow-holes are concerned, we do not share the view about the damaging effects of porosity in castings. It is not an uncommon experience to find that of two test-bars cast and tested similarly the one containing a small blow-hole has the higher strength of the two, the other being sound. Indeed, in a material containing so many minute cavities it would be remarkable if a few blow-holes more or less made any serious difference to the strength. We do not, of course, argue in favour of careless workmanship, but we have noted on many occasions the undue strictness with which inspectors regard a few minute air-locks in a metal.

Research Work for the Non-Ferrous Foundries.

Last week we took the opportunity of inspecting the headquarters and laboratories of the British Non-Ferrous Metals Research Association, which are situated in Regnart Buildings, Euston Street, London, N.W.1, in order to ascertain just what work they have done and propose to do for the non-ferrous foundry. Past researches of a fundamental character and dealing mainly with the effect of impurities in copper and gases in aluminium have been of direct interest to the foundryman in his search for the creation of ideal casting conditions. Then again an abundance of experience with the Durville casting process has been gained and an apparatus is installed for further work. It represents a phase of foundry practice which should be better known and appreciated by foundry owners. Of basic interest to many of our readers is the work which has been carried out on die castings and much useful information is now available in their files and on the benches of the Association's permanent exhibit.

We found that useful service was being given to the foundry industry in two directions. The Association possess a bullion balance capable of determining very accurately the specific gravity of quite large castings. The second service, which is comparatively new, is the installation of a hydraulic ram capable of imposing pressures up to 7½ tons per sq. in., which can be used for testing the soundness of cylindrical castings. Finally, the Association hopes to create a small sand foundry, but this depends somewhat upon the support accorded to it by the foundry industry. From its records of successes in other branches of the non-ferrous industries, such as those discovered in connection with cable sheathings, locomotive condenser tubes and lead pipes, the Association does seem to offer good prospects of money-making results to the foundry industry if they will accord to it an adequate measure of support.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Anti-Foundry Propaganda.

To the Editor of The Foundry Trade Journal.

Sir,—Your issue dated February 9 has just come to hand, and I have been much interested in the editorial entitled "Anti-Foundry Propaganda." You are to be congratulated on your effective remarks, and I should like to amplify them somewhat from this side of the Atlantic.

There is nothing new in the exhibition of a visitor from either one side or the other forming conclusions and uttering opinions calculated to be misunderstood, and often based on an absolute ignorance of the true facts. In fact, it is safe to say that out of this attitude, fostered on the one hand by English lecturers, etc., spending a few weeks here, and on the other hand by American tourists doing the same in Europe, springs the difficulty of obtaining a better understanding of the aims and aspirations of the two peoples. Frothy statements, based on purely local observations, or irresponsible gossip, are the result, and are often given a ready hearing. There is equally nothing new in an engineer decrying the foundry industry. With some it would appear to represent almost a tenet of their religion. Yet this same engineer had trusted his valuable life to steel castings time and time again during his recent visit, and no doubt with every confidence. They have the habit, *demonstrated over long periods of years*, of standing up to their job, even in the most trying circumstances; so much so that we do not trouble to take thought when we entrust our more or less valuable selves to their dependability.

Welded construction is a new baby, and as such is temporarily the spoiled darling of the household. Like the baby, it offers every chance, if wisely controlled, of turning out a useful, dependable member of the family of engineering materials. Equally, it suffers from sundry and manifold limitations and weaknesses, and the wisdom with which these are recognised and admitted will control the speed and efficacy of its acceptance as an adult member of the family. No good purpose is served by decrying it, or endeavouring to prevent its use and development. Rather should we realise that it has a place in the scheme of things, that it represents one more step in the inexorable march of progress.

Through my intimate connection with many committees of both the American Foundrymen's Association and the Steel Founders' Society of America, I am in contact with a fairly representative body of steel-foundry opinion, and perhaps, therefore, may be permitted to offer my view in contrast with Mr. Yerbury's expressed opinion. We are not alarmed by the competition set up by welding or by forgings and stampings. New applications for steel castings continually arise, and will continue to arise. Castings in all metals are improving consistently, both in physical properties and appearance. Alloy additions and special treatments are widening their scope of applicability, opening up new avenues, many of which are such as have never been thought possible for cast parts. Encroachment of steel on malleable, malleable on grey iron, forgings on castings, and so on, has always and will always take place. There is no sharp dividing line, but our experience suggests that this encroachment is mutual and constantly varying in direction, leaving final results more or less steady.

We feel, as founders, that whilst we should most energetically and actively resent ill-founded attacks on our product, our main job and most effective counter is to mind our own business, make better and better castings, keep telling the engineering fraternity of our product and its advancing capabilities, and make castings so good that they want them.

Finally, please don't permit the loosely expressed "impressions" of a "visitor" to cause you too much mental perturbation. Were I to do so, as an Englishman in America, I'd probably find myself in one free fight per week!—Yours, etc.,

Fredk. A. Melmoth,
General Chairman, Steel Division,
American Foundrymen's Association.

The Detroit Steel Casting Company,
Michigan.
February 27, 1933.

The Balanced Blast Cupola.

To the Editor of The Foundry Trade Journal.

Sir,—There have been several articles in the Journal recently dealing with the Balanced Blast Cupola, and I should like to make a few comments.

In all cases I have seen reported, efficiencies and saving in coke consumption have been based on cupolas working continuously all day and dealing with large tonnages of molten iron, where coke-consumption figures are expected to be low and where the weight of coke bed becomes a small fraction of the fusion coke. Also, in these cases, technical supervision is possible.

Continuous-melting cupolas are few in number compared with the ordinary cupola, which has to do its job in 1½ to 3 working hours each day, and the average foundryman would have a much better chance of appreciating the claims made for this cupola if performances were given under these conditions.

Broad claims have been made for this relatively expensive cupola, and it should therefore not be too much to ask for the coke consumption per ton of metal charged in a balanced blast cupola rated at, say, 4 tons per hour and melting 6 to 7 tons per day, the figure to include bed coke.

The average cupola has to work without technical control, and should therefore be very simple to operate, and it would be interesting to learn if there is any automatic feature for balancing the blast, or if this has to be done by the furnaceman from observation, as the average foundryman obviously cannot pay several pounds a week for supervision to save a few hundredweights of coke.—Yours, etc.,

E. A. Roper.

E. A. Roper & Company, Keighley,
March 3, 1933.

Selection of Engineering Materials.

To the Editor of The Foundry Trade Journal.

Sir,—Mr. Hunt's Paper, which appeared in The Foundry Trade Journal on December 22 *et seq.*, and the ensuing discussion, raise certain matters of exceptional interest to those concerned with the strength of materials used in industrial engineering, and thanks are due to Mr. Hunt for his exposition. The methods by which metallurgists can raise the "slip-point" of an alloy are of special interest.

I ask leave to question two points. The first is concerned with tensile strength. It is very probable, as was pointed out, that the so-called "tensile" failure of a material under load is really a failure by shear. It is questionable whether research designed to elucidate the mechanism of failure under tension is nearly so important as other research which would be carried out if conventional ideas of strength and elasticity were modified. So far as cast iron is concerned, the precise mechanism of tensile failure might be termed a metallurgical red herring, because it diverts attention from the fact that, whatever the actual mechanism of tensile failure may be, the tensile strength of cast iron is the same, whether it is developed in a bar under direct axial load or in a beam (which is long relative to its depth) loaded transversely.

The second question is concerned with ductility. The usefulness of ordinary cast iron is severely limited by its lack of ductility. Of two remedies proposed, the reinforcement of cast iron with steel rods (analogous to the reinforcement of concrete) is not, so far as can be seen, practicable. The other, by means of alloy additions, is widely practised with good results. The amount of plasticity or ductility which can be imparted to cast iron without unduly raising the cost, is negligible compared with the ductility inherent in mild steel.

The remedy lies in improved design. Mild steel with 2 per cent. plastic elongation at two-thirds breaking load and 25 per cent. elongation at fracture is comparatively foolproof. Cast iron with less than ½ per cent. plastic deformation at failure needs greater skill in design, therefore, than the high degree of skill employed in riveted or welded mild-steel construction. It is not suggested that a high degree of skill is not employed in cast-iron design, but much research could usefully be concentrated on improvements in design.—Yours, etc.,

A. C. Vivian.

Middlesex.
March 8, 1933.

Anti-Foundry Propaganda.

To the Editor of The Foundry Trade Journal.

Sir,—I have read with astonishment your editorial, "Anti-Foundry Propaganda," in the February 9 issue. I have also read with interest and appreciation copy of a letter sent you by Mr. Frederick A. Melmoth, one of my friends, who, as an English steel foundryman of recognised ability, has been engaged for a few years in steel-casting manufacture in the United States.

I should like briefly to supplement Mr. Melmoth's comments. Comparisons are interesting in more ways than one. Often I am prompted to evaluate current prospects for the American steel foundry as compared with those of the past within my recollection. I left the grey-iron foundry industry in 1900 to begin an apprenticeship as a steel foundryman, and for more than 30 years have had, perhaps, better than an average opportunity (because of my various connections) to note the tendencies in the manufacture and application of steel castings in my own country. Never before have I been able to see in prospect, such promising opportunities in America for the steel-casting industry as I perceive to-day. Naturally, this is due largely to the tremendous development in the manufacture of special steels for castings, including chemical composition and heat-treatment. A clear idea of the extent of this development is obtainable from an examination of the booklet, issued jointly by the American Society for Testing Materials and the American Foundrymen's Association, reporting the symposium on steel castings, held last year.

Preceding and latterly accompanying the purely metallurgical development in steel-foundry practice, there has been noted a very impressive advancement in the many details of steel-foundry technique, not directly related to melting and heat-treating operations. Little by little, the American steel-casting industry has established refinements of practice in moulding, coremaking, gating, heading, etc., which command admiration and stimulate the industry to still greater achievement. And it bears particularly on one statement, made by Mr. Yerbury, to remark that the steel-casting consumer in America has been made fairly conversant with progress in steel-casting manufacture, and wisely shows increasing reliance on a product that is so firmly established as to provoke amazement at statements like those attributed to Mr. Yerbury.—Yours, etc.,

R. A. Bull,
Director.

Electric Steel Founders' Research
Group, 541, Diversey Parkway,
Chicago, Ill.
March 2, 1933.

Midland Foundrymen's Dinner.

MR. FOX'S VIEWS ON MECHANISATION.

The East Midlands Branch of the Institute of British Foundrymen held its Annual Dinner at the Great Central Hotel, Loughborough, on Saturday, March 4, 1933, Mr. C. W. Bigg presiding. About 70 members and friends were present, including the Mayor of Loughborough (Councillor I. Dawson), Mr. Victor Stobie (President of the Institute), Mr. E. J. Fox (managing director, Stanton Ironworks), Mr. T. Makemson (Secretary of the Institute), Mr. S. Perry (President of Leicester Society of Engineers), Mr. V. C. Faulkner and Mr. S. H. Russell (Past-Presidents of the Institute), Mr. J. J. Feasey (President, Lincoln Section, I.B.F.) and Mr. D. H. Wood (President of the Foundry Equipment Association). Mr. E Stevenson (Nottingham) carried out the duties of toast-master.

The Loyal Toast having been honoured, Mr. E. J. Fox, managing director of Stanton Ironworks Company, Limited, submitted the toast of "The Institute of British Foundrymen." He thought the Institute was very much to be congratulated on the work it was doing, in the direction of development, and in its research work. A considerable amount of knowledge had been gained from the metallurgical point of view, and judging from the number of Papers by members, and the discussions, he thought no other scientific institution could show greater enthusiasm in its work. The necessity for research work was greater to-day than ever before. Iron castings were being superseded by fabricated steel, and he hoped that, for the good of our industry, great steps would be taken to improve quality and cheapen price of castings, to combat this new competition. He quoted instances of the growing use of fabricated parts to replace castings, and he thought it to be a very serious menace to both the foundry and pig-iron industries. Much had been said, continued Mr. Fox, about mechanisation of foundries, and he thought it must be admitted that, as compared to Continental concerns, English firms had been less enterprising. In England there had been a plentiful supply of skilled moulders, and that probably accounted for being backward in mechanisation, but he put forward the point of view that mechanisation must be installed to enable this country to compete in the world's markets. Their own effort at Holwell had resulted in a 40 per cent. saving in costs. The Institute, he said, was doing admirable work for the industry, and he had very much pleasure in giving the toast "The Institute of British Foundrymen," coupled with the name of its President, Mr. Victor Stobie.

Mr. Stobie, in response, said he realised that in addressing the East Midlands Branch he was addressing one of the most enthusiastic sections of the Institute. Associated with it was the name of Bunting. Mr. Bunting was the doyen of Branch Secretaries, and if others would keep to the job as long as Mr. Bunting, the Institute would benefit. Mr. Fox, he said, had spoken of research work, and he would tell him of the fine work being compiled by the Institute's Technical Committee, with Mr. Gardom "on the bridge." He did not think the members quite realised the help that could be obtained from the Technical Committee. He related one instance where he had required certain information on the electrical conductivity of a certain alloy. He had tried other sources to obtain the information and had failed, but when putting the question to the technical committee, the answer was immediately given. Referring to fabricated steel, one had to agree that there was a certain field for that and it was of no use to try to compete with castings in that field, but he did not think the position quite so serious as outlined by Mr. Fox. He gave instances where such materials had been used instead of castings and had been complete failures. Fabricated materials had not stood the "test of time" that castings had. Acceptance tests could not replace the experience of years. First appearances were often deceiving. As regards mechanisation, this country had a greater number of small firms, whereas abroad there were mighty concerns backed by industrial banks. The research work carried out by the Institute cost money, and since the only source of revenue to the Institute was in membership subscriptions, he appealed to members to bring along new members to increase the revenue of the Institute to continue its good work.

Mr. T. Makemson, proposing the toast of the East Midlands Branch, said one of the features of the Institute was its democratic nature. He believed quantity and quality went very well together, and all members had a very close voice in its government. The East Midlands Branch covered a very scattered area and it would not have been surprising had it been a small Branch, but such was not the case. Reference has been made to the Technical Committee, and amongst the most enthusiastic members of that committee were two of their members, Mr. Peace and Mr. P. Russell. In the Institute's educational activities, the vice-chairman was one of their past-Presidents, Mr. S. H. Russell. The Branch, like others, had been very successful in its choice of Presidents. He was sure that the energy and enterprise shown in the famous firm with which Mr. Bigg was connected, was reflected in the manner he conducted the affairs of the Branch. The toast was received with musical honours.

Mr. Bigg (Branch-President) said he could imagine no one to be in a better position than the General Secretary to know facts concerning Branches, and it was very gratifying to hear his remarks on their Branch. He thought that the good things Mr. Makemson had said of the Branch were richly deserved, because as President he had had the facilities to see those things; factors that had made his presidential duties a very pleasing job. The Branch was fortunate in having the services of Mr. Bunting. Mr. Bunting's procedure had been to present to the Council, not problems, but accomplished tasks. The general business of the Branch was in the hands of a Council who were always ready when called upon. Of the general members, he would like to pay a tribute to their enthusiasm: the Branch was able to boast of an average attendance of 52, an indication that in the foundry industry there were men willing to sacrifice their one half-day to increase their efficiency in their effort to make the best of the bad times and to equip themselves to meet the good times that are coming. He would like to acknowledge the splendid facilities given by the educational authorities in Loughborough, Derby, Leicester and Nottingham for the Branch meetings. He would like to express his appreciation of the Papers given during the session.

A Witty Speech.

Submitting "The Visitors," Mr. P. A. Russell (Vice-President) said it gave him great pleasure to have that privilege. He was not at all loath to stand up and speak on technical matters, but he was not accustomed to making after-dinner speeches. He proposed, therefore, to take a chemical analysis of the guests. He would first speak of the Mayor of Loughborough, and he felt it an honour that the Branch should each year have the pleasure of the Mayor's company. He would refer to him as the Manganese, which gave strength to the gathering. Then there was the President, Mr. Stobie, and he was the Total Carbon. He wished him every success in his year of office. There was also present the general secretary, Mr. Makemson, who was the Silicon, being the controlling element. He then came to the matter of Sulphur, not always a very helpful constituent, and he must place this to the engineer. Mr. Perry, President of the Leicester Society of Engineers, would control the sulphur. Mr. Perry was not a bad form of Sulphur; he was a patternmaker and had showed his willingness to help the foundryman. Phosphorus indicated life and fluidity and he would attach this to Mr. V. C. Faulkner, Life in The Foundry Trade Journal, and fluidity or fluency in Mr. Faulkner's speeches. Mr. Fox, of course, was the "iron by difference." The guests also included Mr. J. J. Feasey and Mr. E. R. Walters, President and Secretary of the Lincoln Section, I.B.F., but he felt they were too closely associated to be separated from the Branch. He gave all a hearty welcome and thanked them for their presence.

To this toast both The Mayor of Loughborough (Councillor I. Dawson) and Mr. Perry (President of the Leicester Society of Engineers) responded.

A splendid musical programme completed the evening, which was thoroughly enjoyed. The humorist created a good deal of hilarity by his quips at some of the members present and firms represented.

More Anti-Foundry Propaganda.

According to "Iron and Steel" of Canada there were as many foundrymen as welders at the January meeting of the Montreal Chapter of the American Society of Steel Treaters, which was packed to the doors, and Bernard Collitt, who is a neutral, started a proper "free-for-all" by reading an editorial from The Foundry Trade Journal entitled "Castings Displaced by Welding." A correspondent of "The Times" Trade and Engineering Supplement had written: "It can be safely stated that 90 per cent. of the parts made of cast iron can be made of standard steel shapes arc-welded into a homogeneous whole." The irate editor-foundryman responds thus: "Weldings may be defined as an exotic post-war development involving the assembling of steel plates and sections—sometimes of standard dimensions—by means of uncontrolled meroscopic castings. These weldings spring after machining; are liable to excessive corrosion; are subject to being bent, which is usually worse than a break, etc."

This Montreal gathering indulged in no such fireworks as this, but debated with the utmost good humour the merits of the two processes, the concensus of opinion being that welding has already taken its place alongside founding as an essential engineering service.

Mr. Collitt took objection to a statement in a film shown that steel possessed 6½ times the tensile strength of cast iron. The film illustrated a vertical cast-iron bar breaking off short under a load of 1 ton whereas a similar steel bar elongated quite nicely and broke at 6½ tons. Mr. Collitt elicited that the tensile strength of the steel was 31 tons per sq. in. and asked if the tensile strength of cast iron was therefore 31 tons divided by 6.5. Another example of anti-foundry propaganda.

A Correction.

A typographical error appeared in Mr. H. Meadowcroft's Paper, printed in our last issue. The depth of the circular washer on the top of the dome of the pan was actually 2 in., not 2 ft. as stated.

XUM

Foundry Selling Practice.

DIVISION OF TERRITORIES.

By Eric N. Simons

It is legitimate to ask—even if one cannot get an answer—how many foundries have their representatives' districts fixed on a scientific as distinct from a haphazard basis? Probably very few indeed. Foundries will, in the majority of instances, have inherited arrangements dating back from the early history of the firm. These arrangements, in turn, will have been modified here, pulled in a bit there, pushed out a bit somewhere else, until the sales territories, if shown on a map, will present a most complicated and unsystematic appearance. The result will inevitably be inefficient selling in more than one of these districts.

One foundry, for instance, has its salesmen's territories plotted in a most extraordinary way. It will be found, if one examines their map, that one representative covers Barton-on-Humber and also Rhyl and Bangor. His district stretches ludicrously from one side of the country to the other, constricting to a narrow slit in the more central part, so as to avoid the territories of other representatives, whilst in another part he has to cross the actual territory of a colleague, and though he may pass the very doors of a firm in that district half-a-dozen times a year he must not call there. Again, on this same map one will find the representative for Harrow is also the representative for Land's End, while the representative for Glasgow is also the representative for John o' Groats. But this is not all. It will be found that the representative in whose area is Crewe cannot call on Crewe firms, because by some anomaly Crewe belongs to another salesman in a neighbouring district; moreover, the Coventry representative cannot call on certain large firms in Coventry, and the South Wales representative cannot visit certain firms in Briton Ferry.

Existing Obstacles.

Now, it must not be imagined that any one person is to blame for the obvious and maddening illogicalities of this division of territories with its islands and exceptions and reservations. Nor must it be imagined that because these illogicalities are obvious, it is easy to alter them. It is not. If an entire sales force were being discharged, and a whole staff of new men being engaged, it would be possible to redesign the territories as a whole and apportion them out on fair and reasonable lines. But this is not the case. Any foundry selling force at any given time is composed of old-established, fairly well-established, and young representatives in about equal proportions, and the respective demands and interests of all these people have to be studied. The territory of a man who has been carefully cultivating it for 10 or 20 years, has made firm friendships and has built up a good business cannot be calmly shared out amongst other men. It may be that this district is badly planned. It may be that the salesman, however conscientious, cannot work it as efficiently as it should be worked because of its bad arrangement. But for all that, it would not pay to sacrifice the goodwill and connection he has built up to make a theoretical improvement.

The position is that the old men have made their districts, and are too old to view with relish the prospect of starting again with a new district in which they have few friends. The fairly well-established newer men feel that they are getting a grip on their districts, however badly planned, and do not want to be disturbed. So the most-energetic and rational sales manager feels great diffidence in approaching this vexed question of re-arranging territories.

Yet, if the foundry is to prosper, this nettle of territories must be firmly grasped. If the sales manager is convinced that his men are not grouped systematically, that certain districts are too large to be properly combed, that A's mileage is much greater for an equivalent turnover than B's, then he must set to work to plan these arrangements on a more equitable and scientific basis.

How is this to be done? Let us declare, first, that it is not the impossibility it seems. The main essential is tact and a measure of confidence in the salesmen themselves. Then should come careful and absolutely fair and impartial planning. The sales manager, with this task of rearrangement in hand, should first have his turnover figures, by towns and districts, clearly tabulated. If Sheffield produces £10,000 per annum and Leeds £10,000, there is a case for regarding these two towns as roughly equal. He should next work out extremes of mileage, and plan his districts theoretically so as to give each representative a turnover as large as he enjoys (on average) with his existing district, while reducing his maximum mileage (or increasing it, where necessary) to an efficient figure from the point of view of ease of working. Thus, anomalies such as that where A has to cover both Grimsby and Rhyl will be cut out. Anyone who believes that this careful planning of districts can be done in five minutes is mistaken. It is difficult and intricate work, but it must be attempted.

A Give and Take Policy.

Having reached his theoretical apportionment, the sales manager will then have to bring it into being. He can do this by autocratic fiat, which is unwise and disastrous in nine instances out of ten, even if it is possible (which, owing to legal agreements with salesmen, it is not always). But a far-better method is to call his salesmen together expressly for the purpose of conferring on this matter. Directors should be carefully excluded from a conference of this kind, so that the salesmen may have no scruple in stating their views. The conference should begin by the sales manager pointing out tactfully and clearly, in such a way as to appeal to the salesmen's good sense, the anomalies of the existing territorial division. Until he has reasoned his men into admitting the inefficiency of the present system, until he has obtained their assent to the suggestion that in fairness to the foundry some reorganisation is necessary, he should go no farther. If he cannot get even this elementary recognition of facts, he might as well scrap his elaborate plans. But salesmen taken into confidence in a proper way are not so self-centred and silly as to refuse to see facts that stare them in the face. In nine instances out of ten they will generously or grudgingly agree that things might be better arranged.

Now at the back of their minds when they have reached this point will be a good deal of fear and suspicion, however fair-minded they may be. They do not know how far the sales manager proposes to go, and each man will be silently envisaging his best plums wrested from him and handed over to someone else, while they are given in replacement something they do not want. Each man sees his income likely to be reduced by this reorganisation. Now this is where the efficiency of the sales manager's planning should enter. If he has worked out his new territorial divisions on a genuinely fair and efficient basis, it should be possible for him to guarantee to each man a turnover no worse than from his previous district, with a mileage in many instances less. For example, if Rhyl and Bangor yielded £5,000 turnover annually, and cost the Grimsby representative £50 per annum to cover, he would not grumble if he received (say) Norwich and Boston, which yielded a turnover of £4,900, but only cost £20 per annum to cover.

Instead, therefore, of the sales manager beginning to parcel out his new territories at once, he should first outline the system on which the redistribution has been carried out. He should quote the prospective new as compared with the actual present turnovers, the new as compared with the old mileage. When it is seen that the principle of his rearrangements is absolutely fair and impartial, there will be a much greater readiness to consider on their merits alone his new territorial suggestions.

There is little likelihood of the new plans being accepted in their entirety. There are bound to be objections—practical, sentimental, social and what not. These the sales manager should not hastily override. He should give them all due weight, and endeavour as far as possible to fall in with them. The representatives are, however, all gathered together. They have tacitly agreed to some re-arrangement. They are all anxious that any new groupings shall be fair to their colleagues as well as themselves. The clever sales manager will let them as far as possible hammer out the new territories among themselves, with his scheme as a basis. Each man will protect his own interests without his intervention, and among them a compromise will probably be reached that will work better than any imposed scheme. Thus, the sales manager may have planned to give Norwich to A, but B will object that he has spent pounds in cultivating X, Y and Z of Norwich, and feels sure their orders will go elsewhere if he does not keep in touch. A argues that he must have Norwich if he is to give up Hull to C. Probably B will cast about the map and resolve the deadlock by saying that A can have Gainsborough instead, because he has never had time to cultivate Gainsborough as it should be cultivated. A may jump at this. In these discussions the sales manager should exercise a watching brief, and only step in when some suggestion seems to him unfair or unwise.

The ideal sales territory is one which gives a steady turnover as compared with other territories, which can be worked efficiently from a central point, in which the representative should reside, which is not too large to be covered efficiently and which is the saleman's own, without exceptions or reservations. It should also as far as possible be inclusive of more than one type of industry, so that all the brunt of bad trade in a particular industry does not fall on one representative. This may be a counsel of perfection, but it is at least the desired goal.

Catalogues Received.

Gas Lamps.—Catalogue G 25, just released by Messrs. James Keith & Blackman Company, Limited, 27, Farringdon Avenue, London, E.C.4, devotes its 16 pages to describing and illustrating a wide range of high-pressure gas lamps, of both column and suspended types.

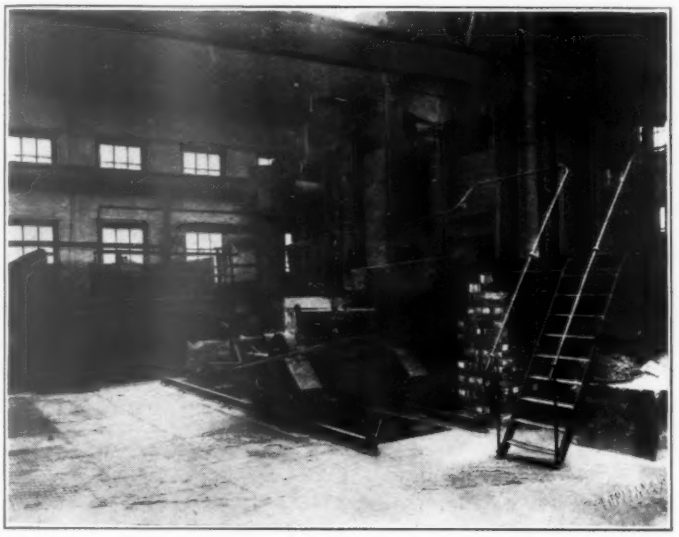
Rotary Compressors. — The compressors, which are fully described in a 16-page catalogue issued by Messrs. James Keith & Blackman Company, Limited, of 27, Farringdon Avenue, London, E.C.4, are of the smaller type, and cover a range from 0.2 to 10 h.p., delivering from 100 to 20,000 cub. ft. of either air or gas per hr., at about 3 lbs. pressure. It will be remembered that all "K.-B." pamphlets are standardised, and we are of opinion that the format chosen is ideal for their range of products. Here and there, however, the printers could, and should, have made a better job of the corners of the "boxes."

The Keighley Gear Company, a subsidiary of Messrs. David Brown & Sons (Huddersfield), Limited, has recently extended its service in the Lancashire area by the establishment of a new branch in Manchester.

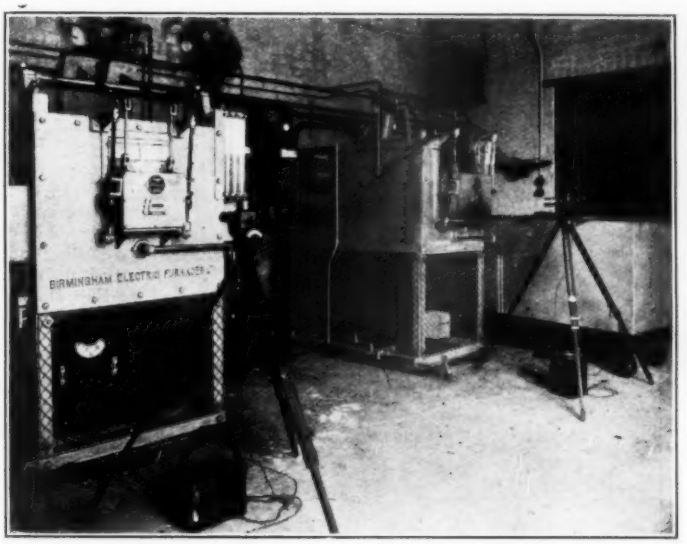
Foundry Education.*

By J. H. Andrew, D.Sc. (Professor of Metallurgy, Sheffield University).

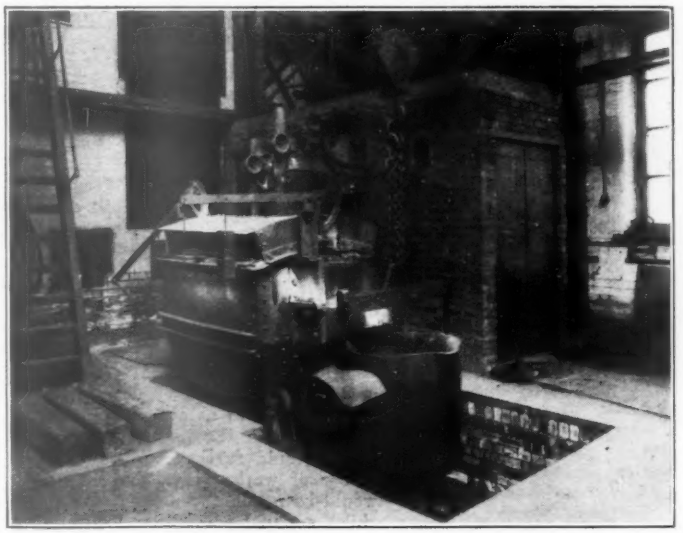
During the last 25 years there have been important developments in the founding industry, iron, steel and non-ferrous, and these have been most marked during the last 10 years. In modern foundries, mechanisation is going on apace, with the result that standardisation and mass production is now becoming established practice. It is, however, largely on the engineering side that the industry has advanced. On the metallurgical side, advancement is only beginning, and it may truly be said that the training of the personnel has hardly kept pace with the development of technique. It can be of little use for the engineer to supply machinery for carrying out foundry processes if a knowledge of the meaning and the working of these processes from the standpoint of metallurgy is not fully understood. The increasing use of alloy steels, cast irons and non-ferrous metals, especially light alloys, demands a thorough understanding of the scientific principles underlying their manufacture, treatment and uses. New types of furnaces for melting and for the purpose of heat-treatment are constantly coming on the market, and the science involved in the carrying out of efficiency tests is becoming, on the grounds of economy, of paramount importance, whilst the study of sands and refractories is almost a science in itself.



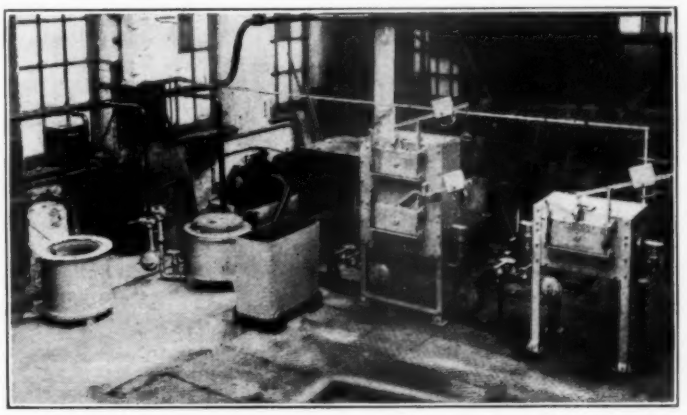
2-ton Siemens Open-Hearth Furnace with Gas-Producer.



Battery of Automatic Electrically-controlled Heat-Treatment Furnaces.



30-cwt. Greaves-Etchells Electric Melting Furnace.



Battery of Gas-Treatment Furnaces and Gas-Crucible Furnace.

* A Paper read before the Sheffield Branch of the Institute of British Foundrymen.

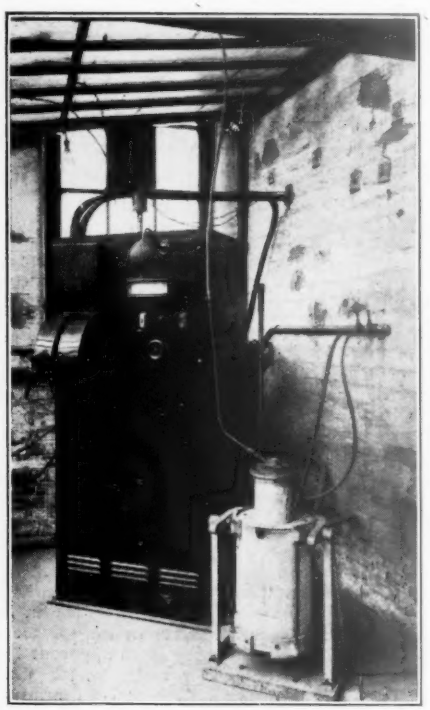
A £40,000,000 Industry.

All modern developments have arisen with a view to producing better articles on a more economic basis, and it is only by creating a state of technical efficiency which in these competitive times may mean a difference between profit and loss, that the foundry industry may be raised to the high status demanded of it. Each foundry has its own problems, and it is only by having in every foundry a trained metallurgist who is capable of solving these problems that any hopes of great development can be realised. Notwithstanding that the estimated value of foundry products in this country amounts to a sum of about £40,000,000 per annum, it is surprising how little of this capital is given up to scientific research and scientific foundry education. At the present time, if a student requires a training in foundry practice, there is no institution of university status in this country where he can gain a degree in foundry science; it is necessary for him to go to Germany, France or America, where foundry schools have long been established. There are, of course, many university centres in this country where a degree in metallurgy may be taken, but such courses do not specialise in the science of founding, and it is becoming more apparent that instruction in foundry practice must differ widely from that normally given to ordinary metallurgical students. For instance, the existing metallurgical courses deal very fully with such subjects as iron and steel manufacture, the extraction of non-ferrous metals and the alloying of them, chemical analysis, along with many subsidiary subjects which are not directly applicable to foundry practice. Matters relating to the actual casting of metals, to re-melting practice, the characteristics of sands, refractories, methods of venting, patternmaking and general

foundry lay-out, are largely omitted from the curriculum or at the most receive but cursory attention.

Sheffield as a Foundry Centre.

Sheffield is the largest steel-founding centre in the world. It is a district with the greatest tonnage of iron castings in the British Isles, and produces the largest iron castings, whilst its non-ferrous industries are varied. It would seem to be rational that Sheffield should be selected as a foundry educational centre, and that opportunities should be given by its University for a complete training in the science and practice of founding, including iron, steel and non-ferrous. The Metallurgical Department of Sheffield University is in a unique position to supply such a training if only it receives support from the industry. It already has, or is in the course of



Ajax-Northrup High-Frequency Electric Furnace.

adding, the essential equipment for the purpose, and possesses an adequate technical staff.

Equipment.

At present the Department is equipped with a small cupola for the melting of pig-iron and scrap and the making of small castings; a 2-ton Siemens open-hearth furnace and a 30-cwt. Greaves-Etchells electric furnace for the making of steel; a small high-frequency electric furnace; a complete crucible melting plant, and a surface combustion gas furnace for the melting of non-ferrous metals. If sufficient funds are forthcoming there will be added a small reverberatory furnace for melting cast iron and scrap and a special type of oil-fired furnace for non-ferrous melting. The heat-treatment plant includes two new Birlec electrically-controlled furnaces, one for annealing and one for high-temperature work; two British Furnaces, Limited, surface-combustion furnaces, one for annealing and a double-muffle furnace for high-temperature work.

The Department also possesses four sets of oxy-acetylene and four sets of arc-welding machines for practical instruction in the operation of welding, and an excellent series of pyrometers, including thermal—both recording and direct reading—and optical and radiation pyrometers. Mr. H. F. Coggon, of Messrs. August's, Limited, has been kind enough to offer the University on permanent loan one of their latest types of core-making machines, sand mixer and core-drying oven, and if funds permit, examples of various types of moulding machinery, electric, pneumatic, hydraulic and hand, would be installed for tuition purposes. It will thus be seen that, with the expenditure of a relatively small amount of money, the equipment of the Department would easily be second to none in the United Kingdom, or, indeed, in the world.

Scientific Apparatus.

With regard to purely scientific apparatus, recent additions of microscopes, potentiometers and other electrical instruments have made possible the most accurate determination of all electrical measurements, thermal, electrical-resistance and magnetic determinations; whilst dilatometers for the determination of coefficients of expansion are also installed. There has recently been added an X-ray plant for, what is usually termed, crystallographical measurements, which has already proved of great value in metallurgical research.

A full complement of machine tools, including lathes, universal milling machine, shaping machine, drilling machines, hack saws, surface grinder and universal grinder, have just been added, so that the Department is in an excellent position not only to cope with its own machining, but also actually to manufacture plant on the premises.

Curriculum.

With regard to the curriculum, it is essential that all the following subjects should be dealt with to a certain extent, some being taken more fully than others:—(1) Chemistry; (2) physics; (3) mathematics, pure and applied; (4) metallurgy of iron and steel; (5) non-ferrous metallurgy; (6) alloys; (7) foundry metallurgy; (8) metallography; (9) moulding sands; (10) refractory materials; (11) geology; (12) pyrometry and physical testing; (13) testing of materials; (14) metallurgical analysis; (15) theory of practice of founding; (16) moulding practice; (17) fuels; (18) costing and economics; (19) furnace design and construction; (20) foundry lay-out; (21) patternmaking; (22) engineering drawing and design; (23) mechanical engineering; (24) electrical engineering; and (25) welding practice.

The actual time given to each subject is a matter for further consideration, and it will require a great deal of thought in order to draw up a complete syllabus including all these subjects. Whatever course is adopted, the subjects of chemistry, physics and mathematics are fundamentals, and the view has been strongly expressed that physics especially should be taken to a higher standard than is usually done in an ordinary degree course, as this subject, along with physical chemistry, forms the basis of modern metallurgy. Assuming for the moment that all these subjects are necessary, the question then arises as to how these can be coupled with a more practical training.

Arrangement of Tuition.

Three possibilities arise: in the first place, such a university training could follow directly upon a practical foundry training, or secondly, the foundry training might be taken after the complete university course has been pursued. The ideal method would, however, appear to be the third possibility, which is to arrange a sandwich course, in which the student, after spending the first session entirely at the University in order to gain a thorough grounding in physics, chemistry and mathematics, would follow this up with three further sessions, in which two terms are spent in the University and the rest of the year in a well-equipped foundry, where he could study actual foundry practice. This method, which has been adopted successfully in many engineering and mining schools, would appear to be the ideal, for it enables a student to apply his theoretical knowledge, as he acquires it from time to time, directly to works practice, so that at the end of four years not only would he have a sound training on the theoretical side, but an excellent knowledge of foundry practice.

Even so, however, it must not be assumed that the training given in the University would be on a purely theoretical basis. Practical founding, including moulding and core making, along with the testing of sands and pattern making, must feature largely in any founding course, and arrangements could readily be made to enable such instruction to be given. In view of the large number of subjects necessary it seems essential to extend the course to four years' duration.

Ph.D. (Founding).

Two methods are possible by which the student could be given a certificate of proficiency; one

Small Cupola.

would be to make the course a graduating one, which would necessitate matriculation at the beginning, terminating in the award of the B.Met. (Founding) degree. A second course would be to adopt what is commonly called an Associateship course, in which the student would be admitted to the University after passing an examination of a lower standard than the matriculation, and at the end of his course he would be awarded an Associateship in Metallurgy (Founding) of the University. At present both these schemes are in operation in the University in the ordinary metallurgical course, and students who have pursued either of them are sufficiently equipped to obtain for themselves a remunerative post in the industry. The value of the course would further be increased by a large number of works visits, and it is hoped that it would be possible to arrange Continental visits, whilst a panel of visiting lecturers, who have specialised in particular branches of the foundry industry, would be drawn up in the hope that they would give the students the benefit of their specialised knowledge. Further, it would be possible for a graduating student to carry out research and obtain the degree of Ph.D. (Founding) after carrying out a course of research in founding problems.

Evening courses would naturally be an important feature in this scheme, which would be wel-

(*Concluded on page* 196.)

Sand Testing in the Foundry.

By W. Y. Buchanan.

(*Continued from page* 173.)

Density.

It is said that the A.F.A. test-piece can be produced at various densities by varying the number of blows of the rammer, but this seems to be rather hopeless, and work in this direction a waste of time. Dr. Ries states that using the A.F.A. standard rammed test-piece increased water content always gave increased density. This refutes the claim made by others that the A.F.A. method is not affected by moisture as compared with double-compression method. Further, the correction of the A.F.A. test is not possible because of the inability to vary the density. The variation of density by variation of number of rams is not considered here to be an accomplished fact.

Dr. Ries also states that the apparent density will vary with the texture of the sand. Much

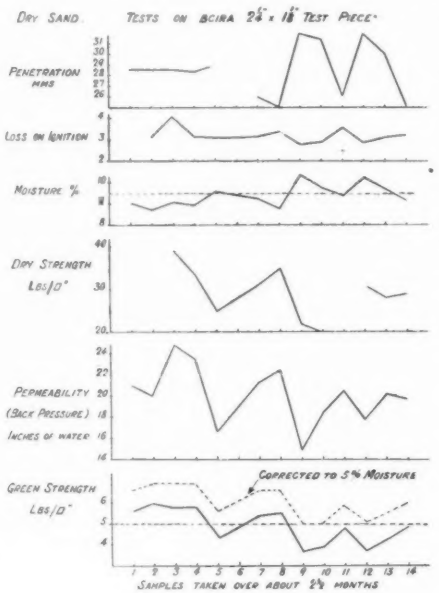

Dry Sand. Tests on BCIRA 2½" x 1½" Test Piece.
Penetration mms
Loss on Ignition
Moisture %
Dry Strength Lbs/□"
Permeability (Back Pressure) Inches of water
Green Strength Lbs/□"
Corrected to 5% Moisture
Samples taken over about 2½ months

Fig. 14.

useful information can be, no doubt, obtained from this. If the true density of the sand itself be taken, *i.e.*, in the dry state, the ratio of this figure to the apparent density, will give the volume of air spaces which, in turn, is closely related to the strength and permeability figures, and comparison between districts can, no doubt, be expressed simply along these lines.

Such data as the true density of the principle raw sands, coal dust, etc., determined in the state in which they are actually ready for use would soon be generally available. Further, the use of a density tester, such as the one which has been described should help such comparison. Obviously much work is required on this question of densities.

Moisture.

In the floor and in sand mixed by hand, the variation of moisture was found to be considerable. This variation was evidently due to the method of adding water to sand. The use of small mechanical aerators is very beneficial, and their proper exploitation will go far to solve the moisture problem in the foundry. For example, to quote actual figures, the machine used to supply a Simpson mixer gave five consecutive batches of sand of the following moisture content:—8.40; 8.37; 8.55; 8.45 and 8.5 per cent. after milling. The sand reaching this machine was quite dry and after wetting and turning over was passed immediately through the machine.

The importance of uniformity of batches cannot be over-stressed, and the moisture variation can be further reduced by suitable storage methods. As shown in the graphs, Fig. 14, the maximum variation is 0.5 per cent. up or down, over two and a-half months when the samples were taken from the storage bin. The results in this particular case do not appear to justify the use of a moisture meter or its purchase for this control of sand only.

Correction for Moisture Effect.

The moisture effect, due to variation of moisture found in daily practice 0.5 per cent. up or down represents changes in green strength of the order of 0.15 lb. per sq. in., up or down, which is not important and may be neglected. As this moisture effect has been raised as an objection to the double-compression method for routine testing, it may be well to show how the corrections can be applied quickly, assuming the errors in moisture to be important.

At first it seems advisable to correct all tests to the weights they would have at 0 per cent. moisture, but as shown in the last Paper* there is a certain amount of water necessary to saturate the clay bond (5 per cent. say). Above this figure the effect is to increase the density by virtue of the extra weight, due to the excess moisture. It is possible that this moisture figure will vary with sands from different districts, but this figure may readily be found. For comparison between districts it may be necessary to express the figures at densities corresponding to 0 per cent. moistures.

Correction of B.C.I.R.A. 2¼ in. by 1½ in. Test Results for Moisture.

It is advisable to test a number of samples having a variation of moisture usually found in daily practice, at two or preferably three densities, that is, one above and one below the normal density. Thus 55 gms., 57 gms., 59 gms., where 57 gms. is the normal foundry density. Plot the graphs strength against density and determine the average gradient, in the example (Fig. 14) 1 unit of density = 22.4 lbs. compression strength. Also 1 gram = 0.0275 density and 1 gram = 0.615 lb. compression strength. The correction in lbs. to add to the reading is given by the formula

$$\left[57 = \left\{\frac{(105 = \text{Moisture}) \times 57}{100}\right\}\right] \times 0.615 \text{ lb.}$$

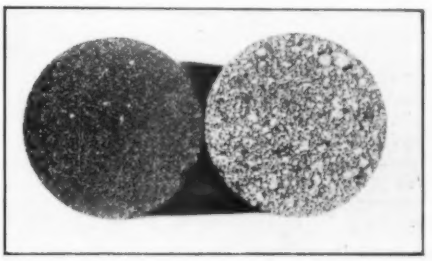
Having determined this correction for a few cases plot these, moisture over 5 per cent. against correction in lbs., and then given the moisture, the correction can be made immediately. The permeability is corrected in the same way.

Moisture Variation and Test Results.

The effect of moisture on the 2¼-in. by 1½-in. double-compression test-piece is clearly shown in Fig. 14, the moisture and green-strength curves being exactly reversed. This seems to contradict the conclusions drawn from tests on the same sample obtained by drying and retesting, which raises the question, "Is it necessary to mill the partly-dried sand to disperse the moisture and has the absence of milling any bearing on this conclusion?"

In Fig. 14 is included a graph showing loss on ignition. Where moisture is measured by drying and re-weighing, this is obtained by a further weighing after ignition at red heat. This loss in weight consists mainly of water of combination plus carbonaceous matter. The water of combination gives a direct measure of the available clay bond. High loss on ignition in samples Nos. 3, 8 and 11 correspond with high back pressure, high green strength and high dry strength, while low loss on ignition corresponds with low green strength, and it is significant that low loss on ignition coincides with high moisture, Nos. 9 and 12.

The penetration-test graph follows the moisture graph, but is apparently not directly affected by variation of clay-bond strength. That is, the resistance to penetration of an ⅛-in. steel wire is due to the degree of packing of the



A B

Fig. 15.—Showing (A) an Oil Sand and (B) a Core Sand.

grains rather than to the tenacity with which they are bound together.

Green Sand.

Where coal dust is added, the characteristics of the sand are modified. The moisture effect is again shown in the permeability and green-strength curves. The curves for penetration show that the A.F.A. 2-in. by 2-in. test-piece standard rammed is subject also to fluctuations of ramming density or hardness with variation

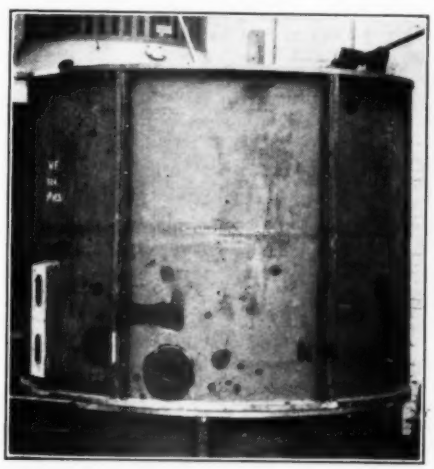


Fig. 16.—Large Plates made under Controlled Sand Conditions.

of moisture. It should be noted that water of combination and combustible matter may be taken together or expressed separately. A check on this is useful for controlling quality, and variations from the average figures will give warning of some change.

Mould Density Determination.

From the example which was given in The Foundry Trade Journal, May 19, 1932, page 302, it is evident that, of all the factors which affect the strength and permeability of sand in ordinary practice, ramming is by far the most important. The differences shown are:—Penetration, 10.5 to 38.5 mm.; green strength, 8.6 to

* Foundry Trade Journal, February 18, 1932, page 113.

1.5 lbs.; permeability, 58 to 11 secs.; and density, 1.62 to 1.28.

The Effect of Passing Sand Through a Sieve.

It is common practice to pass facing sand through a sieve, and this has a tendency to cut the sand into small pellets of the same size as the mesh of the sieve. With light ramming these pellets are not completely deformed, and so an unnatural state exists. There appears to be a sand of fairly uniform grain size all above 20 mesh. On drying these pellets retain their shape and size throughout the operation of casting and confer a somewhat unnatural permeability and strength on the sand which are not in agreement with the information obtained from sieve tests.

Fig. 15 shows at "B" a core sand of this type alongside an oil sand "A" for comparison. Its characteristics were, at 63 gm.: Permeability, 13.0 in.; green strength, 2.94 lbs.; dry strength, 88.0 lbs., and moisture, 8.55 per cent. After drying this sand naturally in a water oven and sieve-testing in this condition, the following figures were obtained:—

Mesh ..	20	40	70	100
Per cent. ..	71.5	23.0	4.5	0.5

and after the material remaining on the 20-mesh sieve had been washed with water there remained only 14 per cent.

The continual use of sieves or riddles as the only aid to sand preparation will very probably favour this sort of thing, and there may be some connection between this pellet formation and the statement sometimes made by the more conservative foundrymen of the old school—"that milling and mixing is of no benefit and that the secret of sand preparation is in the mesh of the riddle." This sand has a very open appearance, but this is not so great as might be expected because for the same density, where spaces occur between these pellets as in the example shown, the pellets themselves must be correspondingly more dense, and this in turn will tend to counteract the tendency toward high permeability.

One would expect, with a sand resembling "B," to get rather tough castings, and that with the introduction of milling and the subsequent elimination of these pellets, to get a decided improvement in surface appearance; this has been the author's experience.

Moist rock-sand, as received, is very liable to form these pellets on sifting, and drying makes them more stable, but the practice of breaking down dried loam bricks and sifting these into a batch of core sand will produce these pellets to the degree shown in the example (Fig. 15).

Oil Sand.

Much has been written about oil sand that is both interesting and instructive, but, as in all other types of sand mixtures, the information should only be taken as a guide for actual tests and decisions made on the result of tests only. Small-scale tests should precede any attempt on a foundry scale, and these can only be properly carried out by the aid of suitable methods of testing.

Thus the effect of moisture additions, the value of using dry sand or wet, time of milling necessary, the correct percentage of oil and the effect of additions of clay-bonded sand on green strength, permeability, dry strength and fineness can be ascertained, and routine methods should include these as well as the examination of raw sand under the microscope. Some sand is liable to erratic proportions of fines due to the difficulty of separating this during shipment, and the percentage of carbonaceous matter varies.

On casting test-bars in oil sand without black wash the surface was very rough, having numerous small holes which proved to be caused by particles of coal on the surface of the mould.

A Practical Illustration.

To illustrate the application of knowledge gained from tests, the following case may be of interest: Twenty-four plates, of the type shown in Fig. 16, 7 ft. 6 in. by 5 ft. by ¾ in. thick were wanted urgently. This was normally a dry-sand job, but the delivery date made it necessary to utilise green sand. The first plate was scabbed and the usual remedy would have been to add more rock sand to the facing sand. As the tests showed the facing sand to be correct, the trouble was sought elsewhere, and by altering the position of two of the gates the trouble was removed.

Another point of interest is that across each plate is shown a slight swell. This is not a bad example, but this sort of thing does not add to the appearance of any job and is often very undesirable. This particular example has been rammed by two men working towards one another and their efforts have not quite blended. This defect might be eliminated by the use of a hardness tester.

Another example is the cover for brine evaporator (Fig. 17). Since the introduction of the milling and mixing process, advantage of the greater strength and permeability has been

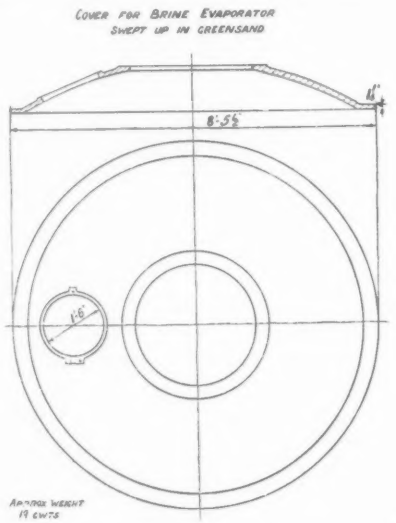


Fig. 17.—Brine Bath Cover.

taken, and larger castings are now made in green sand than formerly.

DISCUSSION.

Mr. J. Currie said that Mr. Buchanan was fortunate in having in the foundry a very large storage bin so that he could maintain bulk supplies of mixed sand and keep the moisture content constant, and in using only one sand mixture. In the foundry with which he was connected they used both facing sand and backing sand and every man made up his own mixture, with the result that the sand varied in moisture 3.5 to 4.0 per cent. daily. Could Mr. Buchanan give a quick permeability test, one that could be carried out at the rate of, say, 20 samples per hr.? Backing sand deteriorated very rapidly and the permeability decreased. The moisture in fine-grained sands was more than in large-grained sand. What form would Mr. Buchanan advise for a quick-permeability test?

Mr. Buchanan replied that he had referred to facing sand only; backing sand did vary considerably. Mr. Currie was mistaken in thinking that he had a large storage bin, as a matter of fact, the bin was not very big and held not more than one day's supply. He considered that the main point was to understand the characteristics of their sands, such as the permeability and moisture contents. They should make a few tests. In regard to the testing, he thought it could be done very quickly, as 12 tests an hr. can easily be made. The permeability test he had explained was designed for foundry use. In his own case, he was not troubled with permeability. Strength tests could be made in a matter of seconds. There were some people who claimed that a whole set of tests could be made in 2 min.

Moisture in Steel Foundry Sand.

Mr. Kirby said that the permeability of a sand was governed to a considerable extent by the moisture content; an increased moisture resulted in decreased permeability. Would Mr. Buchanan say what he considered to be the desirable moisture content for sand for steel-foundry use? There was a considerable variation in the moisture in sand between any two foundries. The figures which Mr. Buchanan had given on the screen were higher than they dare use in steel mouldings.

Mr. Buchanan said, in reply, that the only thing to do was to avoid wide variations. It was necessary to find out what the particular sand in any one foundry would stand, and to stick to that. In his own case the B.C.I.R.A. advised that 5 per cent. moisture was the correct percentage, but the sand would not hold together with 5 per cent. That showed that every sand required a special treatment.

Moisture Content, Weight, Ramming and Moulding Practice.

Mr. A. Bruce said that he considered the moisture content of the sand depended entirely on the weight and size of the castings to be made. In the case of the plant casting (Fig. 1), to which Mr. Buchanan had referred as having been successfully cast by reducing the amount of rock sand, he thought that he would have reduced the amount of coal dust and would have got a finer skin on the casting. A thin casting must be made in drier sand than a thicker one. The top part must be drier on top; otherwise the casting would blow. In dry-sand work more water was required as it was driven off, and a stronger mould was wanted.

Mr. J. Wilson said that, as far as green-sand moulding was concerned, the amount of water would depend upon the weight of the casting. Whether they should add to or take away from the moisture content depended very much upon the ramming. A drier sand required more ramming.

Mr. A. Bruce said that the moisture content depended upon when the mould was to be cast. A mould that was made the same day as it was cast could be made with drier sand, but in the case of a large job which took two or three weeks to make, it would be necessary to have sand with more water or it would not hold together.

Mr. J. Currie said that he recalled a recent experience where a heap of sand was mixed by the moulder and found to contain fully 6 per cent. water; the moulder was told that it was too wet and he must let it down. The sand was used for a week; after the second day the moisture was found to be 3 per cent., and it remained constant at that figure for the rest of the week. He thought that showed that too much water was often added in the idea that more was driven off than was actually the case.

How Control Helps Production.

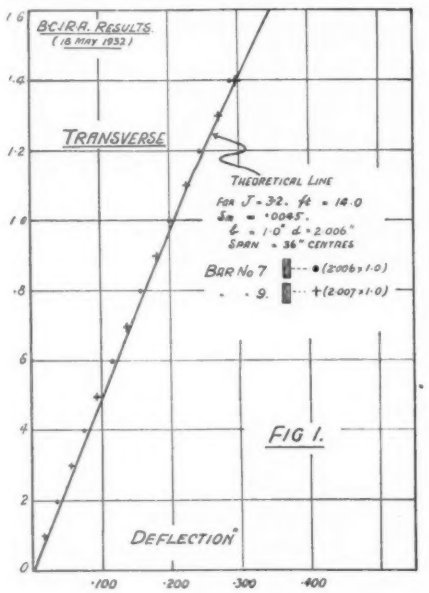
Mr. J. MacIntyre said that, as the foundry manager of the firm to which Mr. Buchanan was attached, he wished to bear testimony to the good results from the control of the sand since Mr. Buchanan undertook it. When Mr. Buchanan first started to control the moisture, the sand appeared to the moulders, and also himself, to be too dry, but after a short time they became accustomed to it, and found a great benefit. They now made a great many castings in green sand which they used always to make in dry sand. They took periodical tests of the moisture and found it to remain reasonably constant. Since adopting the methods of control they had saved an enormous quantity of rock sand by eliminating waste. His principal trouble as far as the moulders were concerned when they were busy was the ramming. There was

(*Concluded on page* 196.)

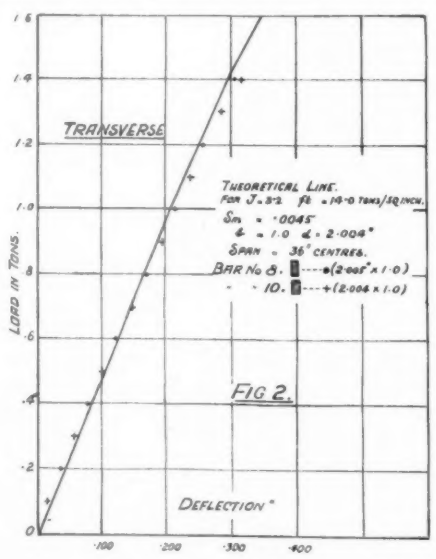
Analysis of B.C.I.R.A. Tests by Form-Factor Method.*

By A. C. Vivian, A.C.G.I. Assoc.M.Inst.C.E.

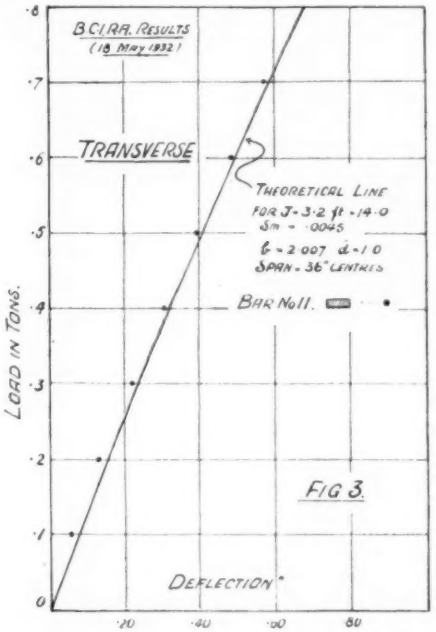
The test results recorded in the following Paper were obtained by the British Cast Iron Research Association to check a method of stress analysis advanced by the writer, who desires at the outset to acknowledge his indebtedness to the Association and its Director, Mr. J. G. Pearce, for carrying out the tests.


B.C.I.R.A. RESULTS (18 MAY 1932)
TRANSVERSE
THEORETICAL LINE FOR J = 3·2. ft = 14·0 Sm = ·0045. b = 1·0" d = 2·006" SPAN = 36" CENTRES
BAR No 7 ●(2·006 x 1·0)
" 9. +(2·007 x 1·0)
FIG 1.
DEFLECTION"

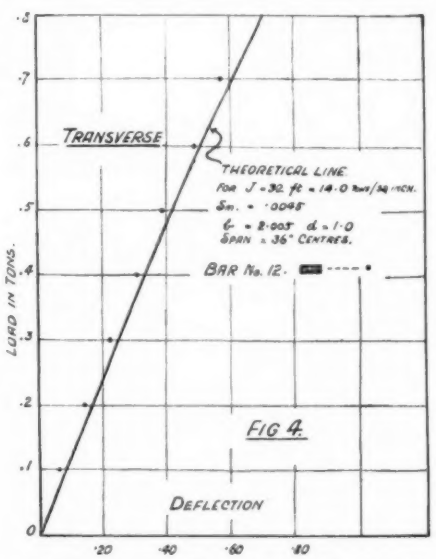
These tests are referred to in the correspondence on a Paper recently presented by the author to the London Branch of the Institute of British Foundrymen. They comprise tensile tests on bars machined from 2-in. by 1-in. bars to 0.798 in. dia., a tensile stress-elongation test on


TRANSVERSE
THEORETICAL LINES. FOR J = 3·2 ft = 14·0 TONS/SQ INCH. Sm = ·0045" b = 1·0 d = 2·004" SPAN = 36" CENTRES.
BAR No 8. ●(2·005" x 1·0)
" 10. +(2·004 x 1·0)
LOAD IN TONS.
FIG 2.
DEFLECTION"

a reduced-diameter bar and transverse tests on bars of rectangular, round and tee section respectively. The transverse tests comprised load-deflection measurements in a number of cases as well as tests to destruction in all cases. In the load-deflection tests, the load was released after each measurement and the permanent set noted. For the purposes of analysis, the difference has been assumed to be the elastic deflection. One particular grade of iron was tested throughout.


B.C.I.R.A. RESULTS (18 MAY 1932)
TRANSVERSE
THEORETICAL LINE FOR J = 3·2 ft = 14·0 Sm = ·0045 b = 2·007 d = 1·0 SPAN = 36" CENTRES
BAR No 11.
LOAD IN TONS.
FIG 3.
DEFLECTION"

The results are recorded in Appendix A, and the whole of them are analysed in Figs. 1 to 8


TRANSVERSE
THEORETICAL LINE FOR J = 3·2 ft = 14·0 Tons/sq inch. Sm = ·0045 b = 2·005 d = 1·0 SPAN = 36" CENTRES.
BAR No. 12.
LOAD IN TONS.
FIG 4.
DEFLECTION

and Appendix C. Theoretical basis of analysis and mathematical formulæ are given in Appendix B.

The Form-Factor Theory.

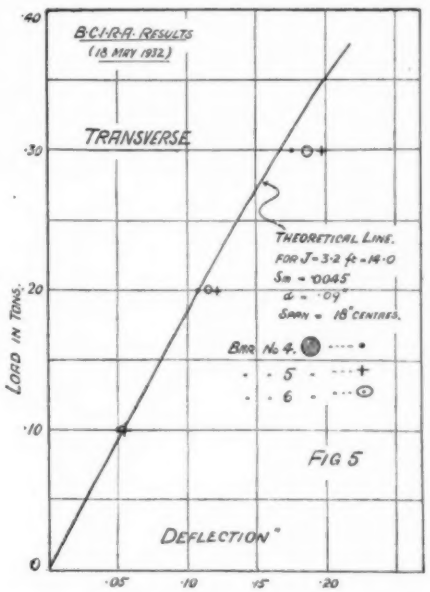
The physical character of cast iron is determined by the following attributes, which are constants for a particular grade of iron and casting conditions:—

(*a*) *Tensile Strength*, which is determinable by direct test. (See Appendix C.)

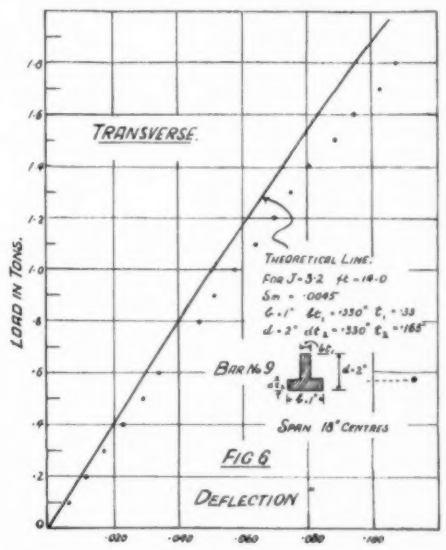
(*b*) *Elastic Character*, which is determinable from tensile and transverse tests. (See Appendix B.)

(*c*) *Ultimate Tensile Strain*, which is not measurable directly, but is determinable from transverse-elastic-deflection tests and/or tensile-extension tests. (See Appendix B.)

(*d*) *Plastic Character*, which is determinable by transverse and tensile tests.


B.C.I.R.A. RESULTS (18 MAY 1932)
TRANSVERSE
THEORETICAL LINE FOR J = 3·2 ft = 14·0 Sm = ·0045" d = ·09" SPAN = 18" CENTRES.
BAR No 4. ●
" 5 +
" 6 ⊙
LOAD IN TONS.
FIG 5
DEFLECTION"

The elastic character is denoted by the form factor and represented in the mathematical analysis by the letter J. It has the numerical value J = 3.2 for the iron under review and it has been found by analysis that a number of different grades of cast iron have the same value

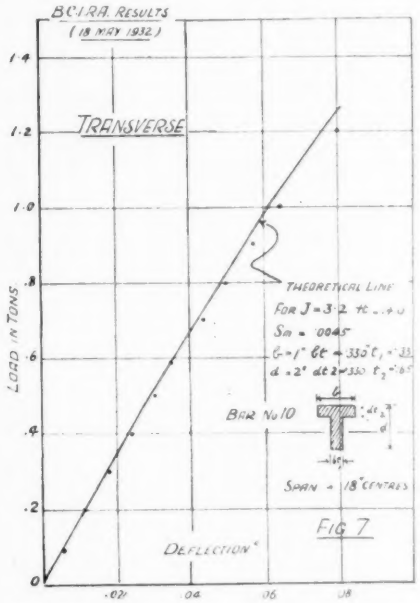

TRANSVERSE
THEORETICAL LINE. FOR J = 3·2 ft = 14·0 Sm = ·0045" b = 1" bc = ·330" t = ·33 d = 2" dt = ·330" t = ·165"
BAR No 9
b = 1·14
SPAN 18" CENTRES
LOAD IN TONS.
FIG 6
DEFLECTION"

of form factor. It corresponds in conventional theory with the ratio R/T = 1.57 for a bar of rectangular cross-section and R/T = 1.69 for a round bar, where R = transverse strength (modulus of rupture) and T = tensile strength.

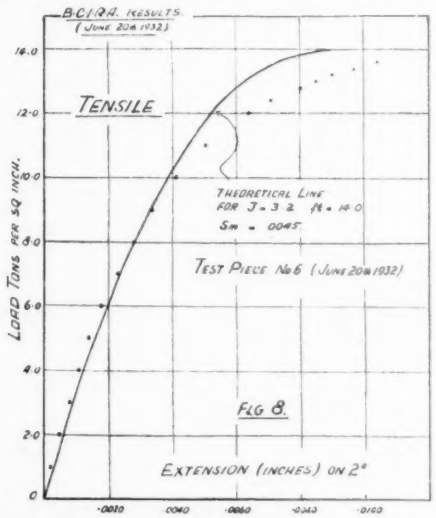
The form-factor theory includes Hooke's Law as a particular case and the form factor of a material which obeys Hooke's Law is J = 2.0. The transverse-stress distribution across a rectangular bar is shown in Fig. 9. The curved line XG to the base line XL is the stress-elastic strain line of the iron in tension and the oppositely-curved line XE to the base line XK is the stress-elastic strain line in compression. When the bending moment is 10 per cent. of the maximum moment of resistance of the beam the transverse-stress distribution will be almost a

* An addendum to a Paper read before the London Branch of the Institute of British Foundrymen.

straight line. The beam will break when the extreme fibre tensile stress GL reaches the tensile strength of the iron. Owing to curvature of the stress lines and the consequent shifting of the neutral axis towards the compression face the beam is 60 per cent. stronger than it should be according to the conventional method of computation based on Hooke's Law. Similar diagrams to Fig. 9 can be prepared for beams of other cross-section.



When the bending moment is 90 per cent. of maximum, the theoretical stress on the tension face is 98 per cent. of the tensile strength, so that failure of a cast-iron beam at 10 per cent. less than the calculated maximum signifies a tensile strength only 2 per cent. less than the maximum as determined by direct test, or alternatively signifies a slight flaw which would have



no appreciable weakening effect at 50 per cent. or less of the maximum moment of resistance of the beam.

The plastic character of cast iron appears to vary considerably, and is probably very sensitive to casting conditions, chill, etc., as well as to the effect of alloy additions. The elastic character appears to be insensitive to such variations. Grades of cast iron of widely varying tensile strength have been found to have the same elastic character.

With these general considerations in mind, the test results and analysis under review provide evidence that a particular grade of iron produced under specified and controlled conditions may be expected to yield remarkably consistent results.

The Analysis.

From a general consideration of all the test results, the iron may be classified as a 13/14-ton iron with the following characteristics:—Form factor J = 3.20; tensile strength ft. = 14.0 tons per sq. in.; ultimate tensile strain Sm = 0.0045.

The theoretical elastic deflection of the various beams calculated as indicated in Appendix B are shown by full lines in Figs. 1 to 7 inclusive. It will be noted that the measured results which are plotted show close agreement. The deviations in elastic deflection in the case of some of the round bars and the tee-bar with flange in tension are attributed to a slight shifting of the neutral axis from its theoretical position due to

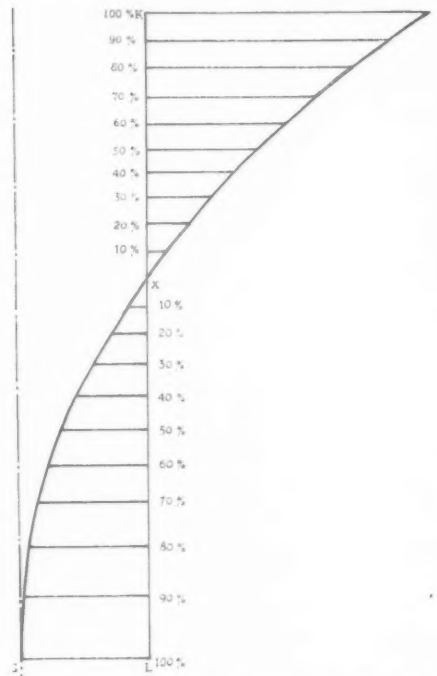


Fig. 9.—A Composite Diagram showing the Transverse Stress Distribution for any Bending Moment from Zero to Maximum Moment of Resistance of a Rectangular Beam of any Dimensions and Elastic Character corresponding with that of ordinary Grey Iron. Lines perpendicular to LK represent Stresses. Distances from X along XL denote Tensile Strains. Distances from X along XK denote Compressive Strains. The Percentages stated denote Pending Moments expressed as Percentages of the Maximum Moment of Resistance.

inequalities in plastic yield on the tension and compression sides of the beam respectively.

The theoretical stress-strain line in tension is plotted as a full line in Fig. 8. This line is calculated from the constants of the material, viz., J. Sm and *ft*, given above, and the basic equation given at the beginning of Appendix B. The plotted points include the plastic as well as the elastic component of total stretch.

It should be noted that the considerable curvature of the tensile stress-elastic strain line is not reproduced in the load deflection lines. The reason is that though the transverse lines become more and more curved as the bending moment increases, the distance between the tension face and the neutral axis increases, and as deflection is inversely proportional to this distance and is directly increased by the curvature, the one effect almost cancels the other out. There remains, however, a slight curvature.

All the transverse tests are analysed in Appendix C in tabular form. The last column, giving calculated tensile strengths at the tension face of each beam respectively at the moment of failure, should be noted. It will be seen that the lowest tensile strength was 13.2 tons per sq. in., justifying the previous suggestion that the iron tested was remarkably consistent.

Conclusion.

The test results which have been analysed, together with an analysis of the plastic component data available in the recorded results, will provide sufficient data for all ordinary design purposes in this particular grade of iron, provided that they are supplemented by a detailed and accurate knowledge of the technique of the foundry.

No consideration has been given to chemical composition nor of charging, melting and casting conditions nor of structure. It will be seen that the problem of the strength of cast iron is here attacked purely from an engineering point of view. The suggestion made is that if certain pieces are tested and the constants of the material determined, the behaviour of other pieces can be predicted with as great accuracy in the case of cast iron as in the case of steel or other materials. If, by a careful control of chemical composition, casting conditions, etc., the soundness and uniformity of castings can be guaranteed, there is no doubt in the writer's mind that the scope of usefulness of cast iron will be widely extended.

APPENDIX A.

Transverse Tests on 2-in. by 1-in. Standard Bar—36-in. Centres.

No.	Breaking load in tons.	Deflection.	Section.
1 ..	1.760	0.498	2.007 by 1.0
2 ..	1.40	0.360	2.0 by 1.0
3 ..	1.675	0.449	2.004 by 1.004

Transverse Tests on 2-in. by 1-in. Standard Bars—36-in. Centres, Tested Flat.

No.	Breaking load in tons.	Deflection.	Section.
4 ..	0.710	0.733	2.003 by 0.992
5 ..	0.810	0.910	2.006 by 1.0
6 ..	0.795	0.891	2.003 by 1.003

Deflection Tests on 2-in. by 1-in. Standard Bars—36-in. Centres.

No.	Load in tons.	Deflection.	Set.	Section.
7 ..	0.1	0.0175	0.0004	2.006 by 1.0
	0.2	0.0375	0.0015	
	0.3	0.057	0.002	
	0.4	0.077	0.0035	
	0.5	0.099	0.005	
	0.6	0.1225	0.0075	
	0.7	0.147	0.011	
	0.8	0.171	0.0133	
	0.9	0.1965	0.017	
	1.0	0.2225	0.0215	
	1.1	0.251	0.028	
	1.2	0.279	0.0355	
	1.3	0.3105	0.0425	
	1.4	0.343	0.0525	
	Broke 1.420	0.349	—	
8 ..	0.1	0.018	0.0005	2.005 by 1.0
	0.2	0.040	0.002	
	0.3	0.0605	0.003	
	0.4	0.084	0.005	
	0.5	0.107	0.007	
	0.6	0.130	0.010	
	0.7	0.156	0.0135	
	0.8	0.1835	0.017	
	0.9	0.2085	0.0207	
	1.0	0.238	0.0263	
	1.1	0.2675	0.0345	
	1.2	0.299	0.041	
	1.3	0.3325	0.049	
	1.4	0.370	0.061	
	Broke 1.6	0.451	—	

No.	Load in tons.	Deflection.	Set.	Section.
9 ..	0.1	0.018	0.001	2.007 by 1.0
	0.2	0.0383	0.002	
	0.3	0.0589	0.0035	
	0.4	0.0806	0.005	
	0.5	0.1024	0.0074	
	0.6	0.1253	0.0106	
	0.7	0.150	0.013	
	0.8	0.1755	0.0165	
	0.9	0.201	0.0205	
	1.0	0.228	0.025	
	1.1	0.2575	0.031	
	1.2	0.286	0.0375	
	1.3	0.3185	0.0465	
	1.4	0.3565	0.0575	
	Broke 1.640	0.448	—	
10 ..	0.1	0.019	0.002	2.004 by 1.0
	0.2	0.041	0.0033	
	0.3	0.062	0.004	
	0.4	0.0844	0.0065	
	0.5	0.108	0.008	
	0.6	0.132	0.0115	
	0.7	0.159	0.015	
	0.8	0.186	0.0185	
	0.9	0.213	0.022	
	1.0	0.245	0.029	
	1.1	0.2745	0.035	
	1.2	0.310	0.044	
	1.3	0.3435	0.0555	
	1.4	0.388	0.069	
	Broke 1.520	0.430	—	

Deflection Tests on 2-in. by 1-in. Standard Bars—36-in. Centres, Tested Flat.

No.	Load in tons.	Deflection.	Set.	Section.
11 ..	0.1	0.070	0.008	2.007 by 1.007
	0.2	0.153	0.014	
	0.3	0.247	0.022	
	0.4	0.349	0.038	
	0.5	0.456	0.058	
	0.6	0.573	0.086	
	0.7	0.710	0.131	
	Broke 0.8	0.872	—	
12 ..	0.1	0.069	0.003	2.005 by 1.0
	0.2	0.152	0.010	
	0.3	0.242	0.019	
	0.4	0.338	0.034	
	0.5	0.440	0.052	
	0.6	0.558	0.073	
	0.7	0.684	0.115	
	Broke 0.702	0.691	—	

Tensile Tests—Machined from 2-in. by 1-in. Bars to 0.798 in. Dia.

No.	Breaking load in tons.	Breaking load in tons per sq. in.	Dia.
1 ..	6.40	12.80	0.798
2 ..	6.40	12.80	0.798
3 ..	6.25	12.50	0.798
4 ..	6.23	12.46	0.798
5 ..	5.97	11.94	0.798
6 ..	5.75	11.85	0.786

Transverse Tests on 0.90-in. Dia. Beams Machined from Broken 2-in. by 1-in. Bars and Tested at 18-in. Centres.

No.	Breaking load in tons.	Deflection.	Dia.
1 ..	0.410	0.378	0.9
2 ..	0.403	0.370	0.9
3 ..	0.418	0.358	0.9

Deflection Tests on 0.9-in. Dia. Beams Machined from Broken 2-in. by 1-in. Bars and Tested at 18-in. Centres.

No.	Load in tons.	Deflection.	Set.
4 ..	0.1	0.055	0.0035
	0.2	0.120	0.012
	0.3	0.210	0.034
	Broke 0.4	0.338	—
5 ..	0.1	0.064	0.009
	0.2	0.145	0.019
	0.3	0.250	0.052
	Broke 0.375	0.365	—
6 ..	0.1	0.056	0.002
	0.2	0.125	0.010
	0.3	0.222	0.036
	Broke 0.380	0.340	—

Transverse Test on T-Section Machined from Broken 2-in. by 1-in. Bars (Tested at 18-in. Centres, Flange Down).

No.	Breaking load in tons.	Deflection.	Section.
7 ..	1.920	0.165	Same as Fig. 6.

Transverse Tests on T-Section Machined from Broken 2-in. by 1-in. Bars (Tested at 18-in. Centres, Flange Up).

No.	Breaking load in tons.	Deflection.	Section.
8 ..	1.205	0.106	Same as Fig. 7.

Deflection Test on T-Bar as above, Tested at 18-in. Centres, Flange Down.

No.	Load in tons.	Deflection.	Set.	Section.
9 ..	0.1	0.007	0.001	See Fig. 6.
	0.2	0.013	0.0015	
	0.3	0.019	0.002	
	0.4	0.025	0.0025	
	0.5	0.032	0.003	
	0.6	0.038	0.004	
	0.7	0.045	0.005	
	0.8	0.052	0.0057	
	0.9	0.058	0.0068	
	1.0	0.066	0.0085	
	1.1	0.0735	0.0095	
	1.2	0.082	0.012	
	1.3	0.089	0.014	
	1.4	0.098	0.0175	
	1.5	0.1085	0.020	
	1.6	0.1185	0.024	
	1.7	0.1315	0.029	
	1.8	0.1425	0.035	
	Broke 1.850	0.152	—	

Deflection Test on T-Bar Machined from Broken 2-in. by 1-in. Bars at 18-in. Centres (Tested Flange Up).

No.	Load in tons.	Deflection.	Set.	Section.
10 ..	0.1	0.0075	0.0013	See Fig. 7.
	0.2	0.014	0.0022	
	0.3	0.021	0.003	
	0.4	0.0275	0.0035	
	0.5	0.0345	0.0045	
	0.6	0.0413	0.0057	
	0.7	0.050	0.007	
	0.8	0.058	0.0085	
	0.9	0.067	0.0105	
	1.0	0.077	0.013	
	1.1	0.0885	0.0168	
	Broke 1.2	0.1025	0.0225	

NOTE.—In this position the bar is difficult to hold in the machine and results may be unreliable.

Cast-Iron Test-Piece No. 6.

Load. Tons per sq. in.	Extension. Inches on 2 in.
0.00	—
1.00	0.00020
2.00	0.00044
3.00	0.00080
4.00	0.00110
5.00	0.00140
6.00	0.00180
7.00	0.00230
8.00	0.00280
9.00	0.00340
10.00	0.00416
11.00	0.00504
12.00	0.00640
12.40	0.00710
12.80	0.00800
13.00	0.00850
13.20	0.00900
13.40	0.00970
13.60	0.0104

Ultimate strength = 13.80 tons per sq. in.

NOTE.—The extensions were taken on a 2-in. gauge length on a standard 1.2-in. bar except that for purposes of extensometer readings it was necessary to reduce the normal 0.798 in. dia. to 0.564 in.

APPENDIX B.

Theoretical Basis of Calculations for B.C.I.R.A. Results.

The curved stress distribution line GXE shown in Fig. 9 is based on the following equation which has as its origin the point L :—

$$p = k.J.y^{J-1} - 1.$$

where p = ratio of stress at any point on the cross-section to the breaking strength, *ft*.
y = ratio of distance at any point from H to total distance HK.
J = the form factor of the iron denoting its elastic character. J is constant for a particular material and appears from test results to be constant for a number of different grades of grey iron.
k = a constant depending on the shape of cross-section and value of J.

From this equation it can be shown that :—

$$\text{Mmax} = \frac{J-1}{2(J+1)} .b.d^2.ft$$ for rectangular beams,

where Mmax = breaking bending moment of beam,
b = breadth of cross-section,
d = depth of cross-section,
ft = breaking strength = ultimate tensile stress as determined on direct test.

For round beams :—

$$\text{Mmax} = \frac{J-1}{2(J+2)} \cdot \frac{\pi}{4} \cdot d^3.ft$$

d = dia. of round bar.

In general the relation for any shape of cross-section is expressed as :—

$$\text{Mmax} = (\text{SMJ}).b.d^2.ft$$

where (SMJ) = the section modulus coefficient and can be evaluated for any shape.

For tee sections with the flange in tension :—

$$(\text{SMJ}) = \frac{k.J}{J+1} \cdot (t_2^{J+1}(1-t1) + t1) - \tfrac{1}{2}.(t_2^2(1-t1)+t1)$$ and $k = \frac{t_2(1-t1)+t1}{t1+(1-t1)t_2^J}$

For tee sections with the flange in compression :—

$$(\text{SMJ}) = \frac{k.J}{J+1} \cdot (1-(1-t1)(1-t_2)^{J+1}) - \tfrac{1}{2}.(1-(1-t1)(1-t_2)^2)$$

and $k = \frac{t_2(1-t1)+t1}{1-(1-t1)(1-t_2)^J}$.

For any tee section geometrically similar to the tee section of the B.C.I.R.A. results and for a form factor J = 3.20 :—

Flange in tension (SMJ) = 0.1598 and k = 1.372
„ „ *compression* (SMJ) = 0.1026 „ k = 0.706

In the case of rectangular (or square) or round beams :—

Rectangular beams (SMJ) = 0.2619 and k = 1.000
Round beams (SMJ) = 0.1661 „ k = 1.078

It will be noted that the values of (SMJ) and K are independent of the actual dimensions of *b*, *d*, and *ft* and are constant for a particular value of the form factor and geometrically similar cross-sections. Hooke's Law is a particular case and is satisfied when J = 2.0, as may be shown by substituting this value for J in the formulæ given above.

The elastic deflection of a beam is given by :—

$$\text{Deflection} = \frac{Sm.L^2}{q.d} \cdot (\text{DI})$$

where Sm = ultimate tensile strain, usually about ½ of 1 per cent. for cast iron.
L = span.
q = height ratio of neutral axis at failure, *i.e.*, LX/LK in Fig. 9.

NOTE.—The values of q are independent of *b*, *d* and *ft*, and for J = 3.20, and the sections under review are :—

Rectangular beam q = 0.5893
Round beam q = 0.570
Tee, flange in tension q = 0.5182
„ „ compression q = 0.6902

d = depth of beam.
(DI) = the deflection integral which can be computed for various types of beam loading and for a particular value of J. It is independent of *b*, *d* and *ft*.

XUM

For simply supported centrally loaded beams as used in the B.C.I.R.A. results the relation between the bending moment at the centre under the load and the deflection integral is stated in Table II, in which :—

m = W/Wmax,
where m = bending moment ratio,
W = load at centre,
Wmax = load at centre which would break the beam calculated from the appropriate Mmax formula.

Table II.—*Relation between Bending Moment and Deflection.*

m.	(DI).	Tensile stress ratio.
0.00	0.0000	0.000
0.10	0.0069	0.150
0.20	0.0141	0.294
0.30	0.0212	0.429
0.40	0.0284	0.555
0.50	0.0357	0.672
0.60	0.0433	0.774
0.70	0.0510	0.860
0.80	0.0591	0.931
0.90	0.0676	0.980
1.00	0.0768	1.000

In calculating the deflections of the B.C.I.R.A. beams, the values of m and (DI) were plotted. Wmax was calculated for each beam. The values of m corresponding with the measured centre load were tabulated, the corresponding value of the deflection integral set down, and the theoretical elastic deflection calculated from the deflection formula given previously.

The relation between m and (DI) has been computed and recorded in Table II for rectangular beams, but is approximately true for beams of any ordinary shape of cross-section.

In calculating the extreme fibre tensile stress in the B.C.I.R.A. transverse tests, the relation between m and the tensile-stress ratio (also given in Table II) was plotted to a sufficiently large scale for the purpose, and the stress ratio corresponding to each value of m obtained. Then calculated extreme fibre tensile stress = stress ratio $\times$ ft.

APPENDIX C.

Table I.—*Measured and Calculated Results for B.C.I.R.A. Tests on the Transverse Strength of C.I. Beams.*

Bar no.	Wmax. Tons.	Measured breaking load. Tons.	Maximum m.	Calculated extreme fibre tensile stress. Tons per sq. in.
Rectangular.				
1 ..	1.718	1.760	—	14.00
2 ..	1.703	1.40	0.822	13.22
3 ..	1.720	1.675	0.974	13.98
4 ..	0.840	0.710	0.845	13.40
5 ..	0.855	0.810	0.949	13.92
6 ..	0.857	0.795	0.927	13.86
7 ..	1.718	1.420	0.828	13.27
8 ..	1.711	1.6	0.935	13.90
9 ..	1.718	1.640	0.955	13.94
10 ..	1.711	1.520	0.888	13.69
11 ..	0.868	0.8	0.922	13.83
12 ..	0.855	0.702	0.820	13.20
Round.				
1 ..	0.377	0.410	—	14.00
2 ..	0.377	0.403	—	14.00
3 ..	0.377	0.418	—	14.00
4 ..	0.377	0.4	—	14.00
5 ..	0.377	0.375	0.995	14.00
6 ..	0.377	0.380	—	14.00
Tees.				
7 ..	1.98	1.920	0.970	13.97
8 ..	1.27	1.205	0.948	13.92
9 ..	1.98	1.850	0.934	13.89
10 ..	1.27	1.2	0.945	13.90

Note.—The fact that the round beams in most cases exhibit a strength greater than the calculated is attributed to plastic yield on the compression face, which would tend to increase the moment of resistance of the beam.

Tensile Tests.—Maximum recorded value of ultimate tensile strength = 13.80 tons per sq. in.

It has been assumed that the maximum breaking strength of the grade of iron tested = 14.0 tons per sq. in. The iron is classified as 13/14-ton iron. Low values of tensile strength as measured, *e.g.*, 11.85 tons per sq. in., are attributed to shear effect in the tensile test-bars or eccentric loading, and not to the material.

The stress-extension relation is plotted on Fig. 8, and the following calculated transverse strengths are based on :—

J = 3.20 ft = 14.0 tons per sq. in. and Sm = 0.0045.

Transverse Tests.—The results are summarised in Table I, in which Wmax = theoretical maximum load which a beam of the iron of the stated cross-section would carry and maximum m = ratio of actual breaking load to Wmax.

Foundry Education.

(*Concluded from page* 190.)

comed by those studying for the City and Guilds Examination in Foundry Work, or for the National Certificate; whilst the practical classes recently introduced into the syllabus of the Trades Technical Classes would derive a very considerable benefit from the foundry equipment.

The view that such a course is highly desirable —indeed, it might almost be said, essential—has been expressed by such eminent people as Sir Robert Hadfield, Dr. W. H. Hatfield, Dr. T. Swinden, Mr. J. E. Hurst, Mr. J. H. S Dickenson, Mr. A. B. Winder, Mr. W. J. Dawson and Mr. W. T. Kitching, as representing the steel and iron-founding industry, and Mr. Victor Stobie and Mr. V. C. Faulkner as representing the Institute of British Foundrymen, and the very fact that Mr. H. F. Coggon has adopted such a generous spirit is a foregone conclusion that he gives this scheme his ardent support.

Financial Backing.

If, however, this scheme of foundry training is to be inaugurated and developed, it is necessary to obtain financial assistance from the industry. When one realises that there are in the country more than 3,000 foundries of different types, it does not seem to be asking a great deal provided each foundry would contribute its annual quota. It is an unfortunate fact that at the present time the foundry trade is anything but good, but a long-sighted view should convince one that those industries which are most depressed are in the greatest need of such a scheme, for by providing them with men trained in the technique and science of founding the opportunity at once presents itself of enabling them to develop on sound, profitable lines. Indeed, in times of stress such as these the need for a highly-trained personnel becomes of the greatest importance. By placing in the foundries men with an adequate scientific and practical training, not only would they be of direct assistance to the foundry in which they were employed, but would in themselves act as a nucleus for the betterment of foundry practice. Even if it were only possible to make a small beginning and develop on broader lines when the industry improved, it would be a step in the right direction.

It is suggested that, if such a scheme was financed by the industry, it should be administered (under the Council of the University) by a delegacy representative of the Institute of British Foundrymen, the Employers' Federations, Trades Associations, Research Associations and the University. This would seem to be the most desirable system, for not only would it enable those who provided the finances to exercise their guiding influence, but it would also enable the Department to be in direct contact with the founding world in general. It is proposed that the scheme should be a national one, embracing all the foundries in the British Isles, in order that every firm may have the privilege of contributing to the scheme and thereby derive benefit from it. Further, by co-operation with the existing bodies in the foundry industry, it would be the direct means of raising the status of the foundry industry.

It is believed that this can to a large measure be attained through the adequate training of those who by birth or by their own efforts are destined to be the executive heads in control of the foundries. Such a training will give those in authority a better appreciation of modern foundry developments, so that managers and foremen and others will no longer work under conditions which they know to be unworthy of their own skill or the reputation of their employers. This condition can arise only by a true appreciation of what education is and can do, and the realisation that there is in this City of Sheffield a university which is prepared to provide such a scheme if only financial aid is forthcoming. The Council of the University has already agreed to the inauguration of such a scheme provided it is financed by the industry.

In conclusion, the author suggested that, if such a scheme goes forward, the Institute of British Foundrymen should create another form of membership, that is, Student Membership of the Institute. He took the opportunity of expressing his gratitude to Dr. J. G. A. Skerl, who, with his usual enthusiasm, has discussed with the author very fully all the points brought up in this Paper, and who has given freely of his valuable advice.

Sand Testing in the Foundry.

(*Concluded from page* 192.)

an inclination not to ram hard enough with the drier sand. They sometimes got swelling from the mould, but as a rule it only happened once when a new man was started, as they always tried to put him to work with a man who was accustomed to their sand. They had only once in 18 months had any trouble with the sand. They had reduced the amount of sprigging necessary since Mr. Buchanan took over control of the sand. There was really no trouble in controlling the moisture in the sand. The exact nature of the control and the suitable moisture depended upon local conditions. It depended where the foundry was situated and to know the virgin sand in the floor. They had effected many economies in the last 18 months or two years and reduced a quantity of scabbing troubles not through any change in the moulding methods but simply through the control of the sand.

The Chairman said he was rather surprised at parts of the discussion as he always regarded it as an accepted fact that there should be only enough water in the sand to make it hold together when rammed and yet they had been debating what was the exact percentage to use.

Mr. Buchanan said that the chairman was correct. What was really required was the minimum amount of moisture that would allow the sand to hold together in the mould until the metal was cast.

The Chairman said that he was sure they would not like to part without expressing their cordial appreciation of Mr. Buchanan's Paper. He therefore asked them to accord in the usual manner their thanks to the author.

At an extraordinary general meeting of the Trent Iron Company, Limited, held at the Atlas Works, Sheffield, on February 27, the following resolution was passed :—" That the company, having ceased to carry on its business and being solvent, be wound up voluntarily; and that Mr. Alexander Morrison, C.A., of 13, St. Ann Street, Manchester, be and he is hereby appointed liquidator for the purpose of such winding-up."

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This Week's News in Brief.

Trade Talk.

Messrs. Christmas & Walters, Limited, engineers and contractors, have removed from 8, Grosvenor Gardens, to 58, Victoria Street, London, S.W.1.

Messrs. Workman, Clark, Limited, Belfast, recently laid the keels of two 400-ft. passenger and cargo motor ships ordered by Messrs. Andrew Weir & Company.

The Fairfield Shipbuilding & Engineering Company, Limited, Govan, Glasgow, have obtained the Admiralty contract for the construction of the destroyer repair ship "Woolwich."

The employees of Messrs. Smith & Wellstood, Limited, Bonnybridge, have made contributions to infirmaries and other charitable institutions totalling £403 2s., of which £203 15s. 7d. went to Falkirk Royal Infirmary.

Messrs. James Shortland & Company, Limited, Wishaw, have been granted permission by the Motherwell & Wishaw Dean of Guild Court to make extensions to their Thistle nail works in Glenpark Street, Wishaw.

Messrs. The E. W. Bliss Company, of Pocock Street, London, S.E.1, have made an arrangement with Messrs. Vickers-Armstrongs, Limited, of Newcastle and Crayford, to manufacture their complete range of sheet-metal working machines hitherto imported from America.

Negotiations for the amalgamation of Messrs. Dorman, Long & Company, Limited, and the South Durham Steel & Iron Company, Limited, with its associated companies, which have extended over several years, are reported to be approaching completion. No official statement is available.

At a meeting held in Greenock, Mr. James Brown, managing director of Messrs. Scott's Shipbuilding & Engineering Company, Limited, Greenock, mentioned that his firm were at present employing 600 men. By the end of June they hoped to start an additional 1,000 men, and before the beginning of next winter another 1,000.

An all-welded steel bridge is being built in connection with the erection of the new £600,000 bridge which is to span the River Tees at Newport, Middlesbrough. This smaller bridge spans a railway on the Durham approach side of the river. A five-span steel structure, 220 ft. long, it is designed for and fabricated by electric-arc welding.

The L.M.S. Railway Company have decided to build two new passenger steamers, at a cost of over £200,000, one to replace the present "Princess Victoria" on the Larne-Stranraer service and the other for the Clyde services. Builders are being asked to tender this month, and both vessels are to be ready for the 1934 season.

Messrs. West's Gas Improvement Company, Limited, of Manchester, have been awarded a contract, amounting to approximately £150,000, for the extension of one of the municipal gasworks in Copenhagen. The contract includes a large installation of the latest type of carbonising plant, part of which will be manufactured in Manchester.

The partnership between A. J. Riley, J. S. Riley, W. Kershaw and Elizabeth Riley, carrying on business as ironfounders at New North Road, Heckmondwike, under the style of the Perseverance Foundry Company, has been dissolved by mutual consent. A. J. Riley, J. S. Riley and Elizabeth Riley are continuing the business under the same style.

The meeting of the London Iron and Steel Exchange, at which Mr. Charles Mitchell, Chairman of the National Committee for the Iron and Steel Industry, is to give an address on "The Position of our Basic Industries from the National and International Points of View," has been postponed until March 21. The meeting will be held at the Cannon Street Hotel at 3 p.m.

After being closed down for two years two blast furnaces at the Shotts Iron Company are to be restarted on March 13 for the production of pig-iron. The by-product plant will be restarted at the same time. Work for approximately 150 men will be provided at the works, and in addition the Shotts miners will obtain steadier work to provide the 1,500 tons of coal required per week.

By permission of Her Majesty the Queen, the new turbine steamer in course of construction by Messrs. William Denny & Bros., Limited, Dumbarton, for Messrs. Williamson-Buchanan Steamers, Limited, is to be named "Queen Mary." The owners are thus maintaining the tradition of giving Royal titles to their ships. The vessel is to be launched at the end of March, and has been specially designed for Clyde passenger service. The propelling machinery will consist of triple screws actuated by high-pressure steam turbines.

Following upon the closing down of the foundry of the Aston Construction Company, Limited, to accommodate extensions to their structural steel department, Mr. J. Kelly and Mr. Chas. Cleaver, who for upwards of twenty years supervised this foundry, have commenced business on their own account at the Walworth Foundry, 237, Walworth Road, London, S.E.1. Both these gentlemen are enthusiastic members of the Institute of British Foundrymen, Mr. Cleaver having served upon the London Section Council for many years, and is now honorary auditor to the Branch.

Mr. G. Steel, general manager of the Stocksbridge works section of the United Steel Companies, Limited, speaking at the annual dinner of the Stocksbridge Works Council, at Stocksbridge, recently, said that a few months ago local people were in a state of fear that the works were going to close. That was an erroneous idea, as the works were going to develop, and the fact that the new research centre was being erected proved that. They were also going to erect a new smelting shop, which, when completed, would be the most up to date in England, if not in the world. Captain R. S. Hilton, managing director of the United Steel Companies, Limited, said that Stocksbridge Works was going to be the "quality works" of the combine.

Personal.

Mr. Richard Leslie Brown has been appointed managing director of Messrs. Hopkinsons, Limited, Huddersfield.

Sir S. George Higgins, chairman of Lloyd's Register of Shipping, has been elected President of the Institute of Marine Engineers for the ensuing year.

Mr. E. Mitchell has been appointed chief accountant to Messrs. Dorman, Long & Company, Limited, in succession to Mr. William Howard Davies.

Mr. Jack R. Walker has been appointed manager of the Larbert Foundry of Messrs. Dobbie, Forbes & Company, in succession to the late Mr. J. C. Walker, who died on March 4. The new manager is a prominent Scottish tennis player.

Dr. E. W. Smith, of British Furnaces, Limited, is to give a Paper on "Long-Distance Gas Transmission in England" before the World Power Conference to be held at Stockholm between June 28 and July 4 this year. Dr. Smith has several times lectured on the use of gas in printing-office foundries.

Mr. Henry Toy, of Toy & Company, engineers, brass and iron founders, Helston, has been elected chairman of the Cornwall County Council, in succession to the late Sir Arthur Carkeek. Mr. Toy has been vice-chairman of the Council for several years past, and did notable work as chairman of the Finance Committee.

Wills.

Gilchrist, Archibald, O.B.E., J.P., engineer and shipbuilder, chairman of Barclay, Curle & Company, Limited, Whiteinch, Glasgow £37,278

The Wales, Monmouth and West of England Branch of the Institute of British Foundrymen held a very successful whist drive at the Park Hotel, Cardiff, on March 11, 1933, as a welcome home to Mr. C. Edward Williams, Vice-President of the Institute, who has been on an extensive tour abroad. Amongst those present were the President of the Institute, Mr. Victor Stobie; the secretary, Mr. T. Makemson; and Mr. W. E. Clements, of Llanelly. The prizes were presented to the successful players by Mrs. J. H. McClelland.

Obituary.

Mr. William Fleming, who was at one time foreman moulder in the Brandon Bridge Building Works, Motherwell, has died, following an operation, in the Western Infirmary, Glasgow, at the age of 54.

Mr. J. M. Holman, J.P., chairman and managing director of Messrs. Holman Bros., Limited, Camborne, manufacturers of mining machinery, etc., died on February 27 at his home at Camborne, aged 75.

Mr. Robert Black, of Stirling Street, Airdrie, a one-legged man, had his remaining leg dragged into revolving machinery while following his employment in the Airdrie Grate Works, and sustained injuries from which he died.

Mr. Edward Andrew Samworth died at Sheffield recently, at the age of 77. Going to Sheffield from London over 40 years ago, Mr. Samworth took up the position of foreman pattern-maker at the Wicker works of Messrs. Walker & Eaton, Limited, later the Brightside Foundry & Engineering Company, Limited. He rose to the position of works manager.

Mr. John Marshall has died at his home in Chesterfield, at the age of 52. Mr. Marshall was for fifteen years foundry manager at the Holwell Ironworks, Melton Mowbray, prior to his appointment in 1919 as foundry manager of the New Works of the Staveley Coal & Iron Company, Limited. Later, he became general manager of the New and Old Works at Staveley on the retirement of Mr. T. Bladen.

The death occurred, at his residence, Octavia Terrace, Greenock, on March 10, of Mr. Matthew Rankin, head of the well-known firm of Rankin & Blackmore, Eagle Foundry, Greenock. Mr. Rankin, who had been unwell for some time, was 77 years of age, and by his death Greenock has lost a generous citizen. Although he did not participate in public affairs, he manifested his interest in his native town in a practical way. In 1925 he and his sister, Miss Rankin, made a gift of £20,000 towards the erection of Larkfield Hospital as an auxiliary to Greenock Royal Infirmary in memory of his brother. Mr. Rankin and his sister also gave a sum of £20,000 to Greenock Corporation for slum clearance.

Mr. John Cameron Walker, J.P., whose death on March 4 was noted in our last issue, was the sole surviving partner of the firm of Messrs. Dobbie, Forbes & Company, Limited, ironfounders, of Larbert, Glasgow, and London, and had been associated with the light-castings industry during practically the whole of his lifetime. During the last three months he had not enjoyed very good health, and following the death of his partner, Mr. George Dobbie, had been able to attend at the works only occasionally. A native of the West of Scotland, Mr. Walker entered upon his connection with the firm more than 50 years ago in the Glasgow office, and later represented the firm in London. About thirty years ago he became a partner, and in company with Mr. Dobbie controlled the affairs of the firm up to the time of his death, his work being more concerned with the commercial activities than the practical side of the work. Mr. Walker devoted much time to public service, and at all times manifested a deep and practical interest in the welfare of Larbert. He was for many years a member of Stirling County Council, and chairman of Larbert Parish Council. He was well known in sporting circles, a keen tennis player in his day, and occupied the position of President of the Scottish Lawn Tennis Association. He was also President of the Larbert curling and bowling clubs. Mr. Walker is survived by Mrs. Walker, two sons and two daughters. The funeral, which took place in Larbert Parish Churchyard on March 14, was attended by a large compnay representative of the firm and various associations with which Mr. Walker was connected.

Standard Abbreviations for Technical Terms.—It is reported in "Steel" that owing to the confusion created by the use of different abbreviations for technical terms, the American Standards Association is formulating tentative national standard abbreviations for the most common scientific and engineering terms. The proposed standards, covering abbreviations ranging from acres to kilovolt-amperes, have just been published by the American Society of Mechanical Engineers.

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Raw Material Markets.

A steady trade continues to be done in the home iron and steel markets, but there has been no sign of any major recovery. The amount of pig-iron going into consumption appears to be increasing, although the improvement is very gradual. Business in finished steel is irregular, but is reported to be on the up grade. Preparations have begun for relighting two steel furnaces at Frodingham, Lincolnshire. It is also announced that the Redbourne Iron and Steel Works, Scunthorpe, are to be reopened in April. In addition, two furnaces were relit this week at the Shotts Ironworks.

Pig-Iron.

MIDDLESBROUGH.—The local demand for Cleveland iron is fairly good, and prices are firm. Several foundries have contracted for deliveries over the next quarter. Despatches of Cleveland iron to Scotland are increasing, owing to the greater activity at the Clyde shipyards. Opportunities for export business remain very limited, and very low figures are quoted in this direction. The delivered prices for No. 3 Cleveland G.M.B. pig-iron are:—Delivered Tees-side works, 62s. 6d. per ton; North-East Coast, 64s. 6d.; Glasgow, 62s. 9d.; Falkirk, 59s. 9d.; elsewhere, 69s. No. 1 Cleveland and siliceous iron are kept at a premium of 2s. 6d. per ton and No. 4 foundry and No. 4 forge at 1s. discount.

The home demand for East Coast hematite is satisfactory, although current output is such that it is impossible to make any large reduction in the stocks of unsold material. A recovery in export business would greatly assist the producers. Mixed numbers remain at 59s. per ton, with 6d. extra for No. 1 quality.

LANCASHIRE.—Forward buying of pig-iron in this district is at the minimum, and current deliveries to the founders make a poor showing. This can, of course, be partly ascribed to the increasing use of scrap iron, but, at the same time, reports are prevalent of a falling-off in activities at the consuming works. Prices keep up, however, on the basis of 67s. per ton for Derbyshire, Staffordshire and North-East Coast brands of No. 3 iron, 65s. 6d. for Northamptonshire, around 82s. for Scottish foundry iron, about 80s. 6d. for West Coast hematite and 75s. 6d. for East Coast hematite, all delivered to works in the Manchester area.

MIDLANDS.—There is nothing new to report with regard to conditions in this area. There seems to be no indication of the usual spring increase in activity. Exhibitors at the heavy section of the British Industries Fair report some inquiries, but it is early to say whether any fresh business will result. Prices for Midland brands of iron are unaltered at 62s. 6d. for Northants No. 3 and 66s. for Derbyshire, North Staffs and Lincolnshire No. 3, delivered Birmingham or Black Country stations, with the usual differences for other grades. Scottish iron comes into this district at from 83s. 6d. to 85s. 6d. net. Medium-phosphorus iron is being produced at from 70s. to 80s. delivered. West Coast hematite remains at the controlled price of 84s. 6d. delivered, but East Coast and Welsh prices are considerably below this level and vary, according to analysis and tonnage, from 74s. to 78s. per ton.

SCOTLAND.—The pig-iron market remains very depressed. Four furnaces are now in blast in Scotland, the Shotts Iron Company having relit two furnaces on Monday. No. 3 Scottish foundry iron remains unaltered at 65s. f.o.t. furnaces, with 2s. 6d. extra for No. 1. No. 3 Middlesbrough is quoted at 62s. 9d. f.o.t. Glasgow and 59s. 9d. f.o.t. Falkirk, while Northamptonshire foundry is obtainable at 2s. 3d. per ton less.

Coke.

The coke market fails to show any improvement in activity, in accordance with conditions in the foundry industry. Best Durham foundry brands range from 36s. 6d. to 38s. 6d. per ton, while Welsh grades range from 30s. to 46s. per ton, according to analysis, delivered in the Birmingham district.

Steel.

The disturbed financial and political conditions abroad are responsible for the quieter tone of the market. Little is known of the progress of the negotiations for the reconstruction of the Continental Steel Cartel, and as a consequence the prices of Continental steel have a weaker tendency. The poor demand from the export markets also has had a depressing effect, as buyers are reluctant to commit themselves beyond their immediate requirements until the position becomes clearer. Business in semi-finished steel has improved slightly of late, and although an occasional isolated transaction in Continental material is heard of, practically all business passing is going to the British producers. Comparatively few Continental makers are offering material in the British market at current prices. Quiet conditions have ruled in the finished-steel market, but there has been rather more inquiry during the past few days on home account. Inquiry from overseas, however, has been confined to small tonnages.

Scrap.

The scrap-iron markets generally remain firm. In the Cleveland area, both machinery metal and ordinary heavy cast iron are in good demand, but the merchants have only limited supplies for disposal, and are not anxious to increase their commitments. Founders in the Midlands are buying machinery scrap at 47s. 6d. per ton, delivered, while heavy cast iron stands at about 42s. 6d. Prices are firm in the Scottish area. In South Wales, dealing in scrap iron is limited, as the local foundries are not very busy.

Metals.

Copper.—Confidence in the copper market was seriously undermined by the news of the American bank moratorium, and prices slumped, but there has been a recovery in the last few days. This was due to the partial clarification of the American financial situation and also to widespread buying of commodities in the United States as "cover" against a possible depreciation of the dollar. The American producers were also holding off the market pending the re-quoting of the dollar. Greater interest has been shown in this commodity by consumers in Europe, particularly on the Continent, but the position of the consuming industries actually shows little improvement.

Prices have been:—

Cash.—Thursday, £28 10s. to £28 11s. 3d.; Friday, £28 11s. 3d. to £28 12s. 6d.; Monday, £29 3s. 9d. to £29 5s.; Tuesday, £28 15s. to £28 16s. 3d.; Wednesday, £28 6s. 3d. to £28 7s. 6d.

Three Months. — Thursday, £28 15s. to £28 16s. 3d.; Friday, £28 17s. 6d. to £28 18s. 9d.; Monday, £29 8s. 9d. to £29 10s.; Tuesday, £29 to £29 1s. 3d.; Wednesday, £28 11s. 3d. to £28 12s. 6d.

Tin.—The tin market has recovered from its recent low levels, but it is feared that much of the advance must be attributed to speculative support, which inevitably leads to a reaction. Messrs. Rudolf Wolff & Company state in their report that "trade demand is well maintained in this country, and moderately so on the Continent, but in America unsettled conditions have obtained. The outlook is still uncertain, but if, as is assumed in some quarters, the crisis in America will result in the financial and economic position being re-established on a sounder basis and in some restoration of confidence, which for some time has been sadly lacking, the future would seem to offer a fair prospect of moderate improvement. From the latest announcement with regard to output, it would seem that efforts will not be spared at least to maintain equilibrium between supply and demand, and therefore even a moderate expansion in consumption would materially help the situation."

Prices of standard tin have been:—

Cash.—Thursday, £148 17s. 6d. to £149 2s. 6d.; Friday, £149 2s. 6d. to £149 5s.; Monday, £150 to £150 2s. 6d.; Tuesday, £149 5s. to £149 7s. 6d.; Wednesday, £148 17s. 6d. to £149.

Three Months. — Thursday, £149 10s. to £149 12s. 6d.; Friday, £149 17s. 6d. to £150; Monday, £150 12s. 6d. to £150 15s.; Tuesday, £149 17s. 6d. to £150; Wednesday, £149 12s. 6d. to £149 15s.

Spelter.—There has been no expansion in the demand from consumers in this country, but the rate of consumption is well maintained. Most of the works are fairly well covered for the moment. The firmness of the market at the present moment may be frankly ascribed to recent speculative buying. The Cartel statistics for February showed a decrease in stocks of over 1,000 tons.

Price fluctuations:—

Ordinary.—Thursday, £14 13s. 9d.; Friday, £14 17s. 6d.; Monday, £15 2s. 6d.; Tuesday, £14 17s. 6d.; Wednesday, £14 18s. 9d.

Lead.—Messrs. Henry Gardner & Company report that "this metal has been very active, and with excellent consumptive demand continuing to be shown, and sellers on the market restrained, values have advanced materially. The inflationary tendency in the States has evidently induced the buying of commodities there and a big lead business is reported."

Daily market prices:—

Soft Foreign (Prompt).—Thursday, £11 2s. 6d.; Friday, £11 2s. 6d.; Monday, £11 5s.; Tuesday, £10 17s. 6d.; Wednesday, £10 11s. 3d.

Notes from I.B.F. Branches.

Burnley Section. — At the annual general meeting, held on March 9, the following officers were re-elected *en bloc*:—Chairman, Mr. J. Taylor; Vice-Chairmen, Mr. F. Harris and Mr. L. Wharton; Councillors, Mr. J. Lowe and Mr. J. Cross; Hon. Secretary, Mr. J. Pell. The remainder of the evening was devoted to the presentation of a Paper by Mr. W. Haworth, of Burnley, on "Welding." The Paper disclosed that plain cast-iron bars of similar composition were tested before and after welding. In general, the welded bars broke at lower loads than those not so treated.

Contracts Open.

Cape Town, April 12.—Electrically-driven sewage pumping equipment, for the Cape Town Electricity Department. The Department of Overseas Trade. (Reference G.X. 12,344.)

Northam, March 28.—Supply and laying of 3,030 yds. of 6-in. dia. cast-iron water mains, for the Northam Urban District Council. The Council Surveyor, Cross Street, Northam, Devon. (Fee £2 2s., returnable.)

Southport, March 20.—738 tons of 18-in. dia. cast-iron pipes and specials, for the Southport and District Water Board. Mr. C. Burton Ede, engineer and manager, 14, Portland Street, Southport.

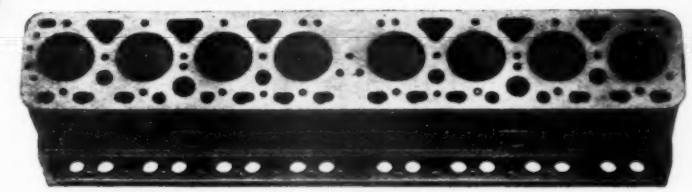
New Companies.

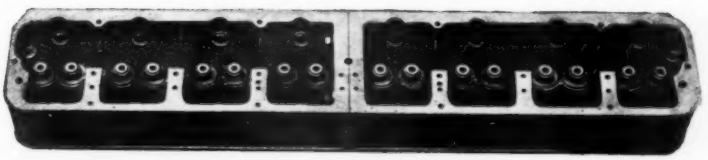
Britannia Iron & Steel Works, Limited, Kempston Road, Bedford.—Capital, £200,000. Directors: E. Homberger, E. Le Bas, H. S. Loebl, J. Buehrer and R. Osborne.

Carter & Wright (Engineers and Machine Tools), Limited, Hexagon Ironworks, Pellon Lane, Halifax.—Capital £2,500. Directors: S. A. Wright, J. H. Holroyd, J. E. Greenwood and Clarabel A. Wright.

New Application of Cr-Mn-Si Steel.—A recent issue of "Steel" states that railroads and car-builders are considering the use of chromium-manganese-silicon steel as a means of reducing the weight of cars. This steel contains 1.20 per cent. manganese, 0.50 chromium and 0.75 silicon. In the as-rolled condition it has about 45 tons tensile strength, 27 tons yield point and 22.5 proportional limit. It is readily welded, and is now being produced commercially in the form of shapes, plates, tubing and bars. Welded cars, built of this steel, would represent a saving of about 40 per cent. in weight thus cutting down materially on the non-revenue load

FRODAIR PIGIRON

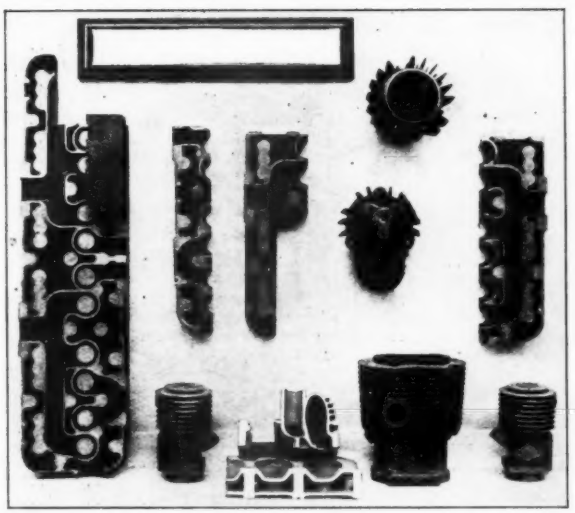




Straight-8 Block and Head Cast with FRODAIR.

FOR THE MOTOR TRADE

Air cooled Cylinders, Heads and Barrels; also sections of water-cooled Heads; all cast with FRODAIR.



Note.
Customers invited to send photographs: Comments welcomed.

Best after Test

FRODAIR IRON & STEEL CO., LTD.,
FENCHURCH HOUSE,
LONDON.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	28	6	3
Three months	28	11	3
Electrolytic	33	5	0
Tough	30	0	0
Best selected	30	10	0
Sheets	61	0	0
India	41	0	0
Wire bars	34	10	0
Do., April	34	5	0
Do., May	34	0	0
Ingot bars	34	10	0
H.C. wire rods	36	15	0
Off. av. cash, February	28	10	6¾
Do., 3 mths., February	28	15	4½
Do., Sttlmnt., February	28	10	6
Do., Electro, February	32	14	9¾
Do., B.S., February	31	3	9
Do., wire bars, February	32	18	6
Solid drawn tubes			9½d.
Brazed tubes			9½d.
Wire			6½d.

BRASS.

Solid drawn tubes	8¾d.
Brazed tubes	10¾d.
Rods, drawn	7⅝d.
Rods, extd. or rlld.	4¾d.
Sheets to 10 w.g.	7⅜d.
Wire	7⅛d.
Rolled metal	6¾d.
Yellow metal rods	4¼d.
Do. 4 × 4 Squares	5¼d.
Do. 4 × 3 Sheets	5¼d.

TIN.

	£	s.	d.
Standard cash	148	17	6
Three months	149	12	6
English	150	0	0
Bars	153	0	0
Straits	155	0	0
Australian	152	15	0
Eastern	154	0	0
Banca	155	5	0
Off. av. cash, February	148	12	7½
Do., 3 mths., February	149	1	2¼
Do., Sttlmt., February	148	12	6

SPELTER.

	£	s.	d.
Ordinary	14	18	9
Remelted	14	0	0
Hard	11	17	6
Electro 99.9	17	5	0
English	15	12	6
India	14	0	0
Zinc dust	20	10	0
Zinc ashes	2	5	0
Off. aver., February	13	19	10½
Aver. spot, February	13	17	3¾

LEAD.

	£	s.	d.
Soft foreign ppt.	10	11	3
Empire	10	2	6
English	12	5	0
Off. average, February	10	11	6
Average spot, February	10	8	7½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	0	0
Do., V.M. ex-whse.	23	0	0
Rods	26	0	0
Boiler plates	22	0	0
Battery plates		—	

ANTIMONY.

	£	s.	d.	£	s.	d.
English	37	10	0 to 42	10	0	
Chinese				28	5	0
Crude					—	

QUICKSILVER.

	£	s.	d.
Quicksilver	9	5	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro silicon—	
25%	£8 0 0
45/50%	£13 15 0
75%	£19 10 0
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free of Mo.	6/3 per lb.
Ferro-titanium—	
23/25% carbon-free	10d. lb.
Ferro-phosphorus, 20/25%	£17 10 6
Ferro-tungsten—	
80/85%	1/7½ lb.
Tungsten metal powder—	
98/99%	1/10½ lb.
Ferro-chrome—	
2/4% car.	£29 5 0
4/6% car.	£23 7 6
6/8% car.	£22 15 0
8/10% car.	£22 10 0
Ferro-chrome—	
Max. 2% car.	£34 10 6
Max. 1% car.	£36 10 0
Max. 0.70% car.	£40 2 6
70% carbon-free	1/– lb.
Nickel—99.5/100%	£240 to £245
"F" nickel shot	£216 0 0
Ferro-cobalt	7/3 lb.
Aluminium 98/99%	£100 0 0
Metallic chromium—	
96/98%	2/9 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export (nom.)	£9 15 0
Metallic manganese—	
94/96% carbon-free	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten 2s. 0d.
Finished bars, 18% tungsten 2s. 9d.
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares, 3 in. and over 4d. lb.
Rounds and squares, under ½ in. to ¼ in. 3d. lb.
Do., under ¼ in. to $\frac{1}{16}$ in. 1/– lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in. 3d. lb.
Do., under ½ in. × ¼ in. 1/– lb.
Bevels of approved sizes and sections 6d. lb.
Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel				2	5	0
Bundled steel and shrngs.	1	17	6 to	2	1	6
Mixed iron and steel	2	0	0 to	2	1	0
Heavy cast iron				2	5	0
Good machinery	2	8	0 to	2	10	0
Cleveland—						
Heavy steel				2	5	0
Steel turnings				1	12	6
Cast-iron borings				1	3	6
Heavy forge				2	10	0
W.I. piling scrap				2	2	6
Cast-iron scrap	2	5	0 to	2	7	6
Midlands—						
Light cast-iron scrap				2	0	0
Heavy wrought iron				2	7	6
Steel turnings, f.o.r.				1	6	6
Scotland—						
Heavy steel	1	18	6 to	2	0	0
Ordinary cast iron	2	5	0 to	2	6	6
Engineers' turnings				1	11	6
Cast-iron borings	1	11	6 to	1	12	6
Wrought-iron piling				2	3	0
Heavy machinery	2	10	0 to	2	11	6

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	21	0	0
Brass	16	0	0
Lead (less usual draft)	9	10	0
Tea lead	8	0	0
Zinc	8	0	0
New aluminium cuttings	74	0	0
Braziery copper	19	0	0
Gunmetal	18	0	0
Hollow pewter	80	0	0
Shaped black pewter	60	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	65/–
Foundry No. 3	62/6
,, at Falkirk	59/9
,, at Glasgow	62/9
Foundry No. 4	61/6
Forge No. 4	61/6
Hematite No. 1, f.o.t.	59/6
Hematite M/Nos., f.o.t.	59/–
N.W. Coast—	
Hem. M/Nos. d/d Glas.	68/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/–
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	62/–
,, No. 3 fdry.	66/–
Northants forge	58/6
,, fdry. No. 3	62/6
,, fdry. No. 1	65/6
Derbyshire forge	62/–
,, fdry. No. 3	66/–
,, fdry. No. 1	69/–
Scotland—	
Foundry No. 1	67/6
,, No. 3	65/–
Hem. M/Nos. d/d	66/–
Sheffield (d/d district)—	
Derby forge	59/6
,, fdry. No. 3	63/6
Lincs forge	59/6
,, fdry. No. 3	63/6
E.C. hematite	73/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	67/–
Staffs fdry. No. 3	67/–
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/–
Dalzell, No. 3 (special)	102/6 to 105/–
Glengarnock, No. 3	82/–
Clyde, No. 3	82/–
Monkland, No. 3	82/–
Summerlee, No. 3	82/–
Eglinton, No. 3	82/–
Gartsherrie, No. 3	82/–
Shotts, No. 3	82/–

FINISHED IRON AND STEEL.

Usual district deliveries for iron; delivered consumer's station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.)	9	0	0 to	9	15	0
Nut and bolt iron	7	12	6 to	8	0	0
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.	12	10	0			
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	8	0	0 to	9	0	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ⅜ in. (Untested)	6	15	0 & up.			
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)	9	10	0 & up.			
Black sheets, 24g. (10-t. lots)				9	10	0
Galv. cor. shts. ,,				11	15	0
Galv. flat shts. ,,				12	5	0
Galv. fencing wire, Sg. plain				14	0	0
Billets, soft	5	0	0 to	5	7	6
Billets, hard	6	12	6 to	7	2	6
Sheet bars	4	15	0 to	5	2	6
Tin bars				4	15	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	11½d.
Rods	10½d.
Tubes	15d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless stated.

	Dols.
No. 2 foundry, Phila.	13.34
No. 2 foundry, Valley	14.50
No. 2 foundry, Birm.	11.00
Basic	15.39
Bessemer	16.89
Malleable	16.39
Grey forge	16.39
Ferro-mang. 80%, seaboard	68.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	1.86
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.55
Sheets, black, No. 24	2.00
Sheets, galv., No. 24	2.60
Wire nails	1.85
Plain wire	2.10
Barbed wire, galv.	2.35
Tinplates, 100-lb. box	$4.25

COKE (at ovens).

Welsh foundry	20/– to 22/6
,, furnace	16/– to 17/–
Durham and Northumberland—	
,, foundry	21/– to 25/–
,, furnace	13/3
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		15/9 to 16/–
,,	28×20 ,,		31/6 to 32/–
,,	20×10 ,,		22/7½ to 23/–
,,	18¾×14 ,,		16/4½ to 16/7½
C.W.	20×14 ,,		14/–
,,	28×20 ,,		29/3 to 29/6
,,	20×10 ,,		19/10
,,	18¾×14 ,,		14/–

SWEDISH CHARCOAL IRON & STEEL.

	£	s.	d.	£	s.	d.
Pig-iron	6	0	0 to	7	0	0
Bars-hammered, basis	16	10	0 to	17	0	0
Bars and nail-rods, rolled, basis	15	17	6 to	16	5	0
Blooms	10	0	0 to	12	0	0
Keg steel	32	0	0 to	33	0	0
Faggot steel	18	0	0 to	23	0	0
Bars and rods dead soft, st'l	10	0	0 to	12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£ s. d.	
Mar. 9 ..	28 10 0	inc. 7/6
„ 10 ..	28 11 3	„ 1/3
„ 13 ..	29 3 9	„ 12/6
„ 14 ..	28 15 0	dec. 8/9
„ 15 ..	28 6 3	„ 8/9

Electrolytic Copper.

	£ s. d.	
Mar. 9 ..	32 5 0	inc. 5/–
„ 10 ..	32 15 0	„ 10/–
„ 13 ..	33 15 0	„ 20/–
„ 14 ..	33 15 0	No change
„ 15 ..	33 5 0	dec. 10/–

Standard Tin (cash).

	£ s. d.	
Mar. 9 ..	148 17 6	inc. 5/–
„ 10 ..	149 2 6	„ 5/–
„ 13 ..	150 0 0	„ 17/6
„ 14 ..	149 5 0	dec. 15/–
„ 15 ..	148 17 6	„ 7/6

Tin (English ingots).

	£ s. d.	
Mar. 9 ..	150 0 0	inc. 5/–
„ 10 ..	150 5 0	„ 5/–
„ 13 ..	151 5 0	„ 20/–
„ 14 ..	150 10 0	dec. 15/–
„ 15 ..	150 0 0	„ 10/–

Spelter (ordinary).

	£ s. d.	
Mar. 9 ..	14 13 9	inc. 2/6
„ 10 ..	14 17 6	„ 3/9
„ 13 ..	15 2 6	„ 5/–
„ 14 ..	14 17 6	dec. 5/–
„ 15 ..	14 18 9	inc. 1/3

Spelter (Electro, 99.9 per cent.).

	£ s. d.	
Mar. 9 ..	17 0 0	inc. 5/–
„ 10 ..	17 5 0	„ 5/–
„ 13 ..	17 10 0	„ 5/–
„ 14 ..	17 5 0	dec. 5/–
„ 15 ..	17 5 0	No change

Zinc Sheets (English).

	£ s. d.	
Mar. 9 ..	24 0 0	No change
„ 10 ..	24 0 0	„ „
„ 13 ..	24 0 0	„ „
„ 14 ..	24 0 0	„ „
„ 15 ..	24 0 0	„ „

Lead (English).

	£ s. d.	
Mar. 9 ..	12 10 0	inc. 5/–
„ 10 ..	12 10 0	No change
„ 13 ..	12 15 0	inc. 5/–
„ 14 ..	12 10 0	dec. 5/–
„ 15 ..	12 5 0	„ 5/–

Imports and Exports of Iron and Steel Castings in February and the two months 1933, compared with February and the two months 1932.

	February, 1932.	February, 1933.	Two months, 1932.	Two months, 1933.	February, 1932.	February, 1933.	Two months, 1932.	Two months, 1933.
Imports.	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Pipes and Fittings, Cast	580	36	768	207	8,051	1,073	11,202	4,506
Castings, in the Rough, Iron	154	13	177	20	2,963	676	3,430	871
„ „ „ Steel	441	66	688	121	9,430	1,260	13,603	2,038
Hollow-ware, Cast, not Enamelled	1	2	1	3	76	143	76	214
„ „ Enamelled	3	—	3	3	291	11	323	178
Exports.								
BUILDERS' CASTINGS—								
To Argentine Republic	19	8	73	32	941	756	3,347	1,348
„ Irish Free State	325	246	740	479	13,117	9,224	31,915	19,488
„ British South Africa	105	127	301	308	3,864	5,283	10,688	11,927
„ „ India	94	78	167	187	3,247	2,586	5,844	6,205
„ New Zealand	20	41	41	86	1,466	2,379	2,399	3,700
Total (including other countries)	867	963	2,053	1,917	35,425	35,363	86,276	73,702
PIPES AND FITTINGS—CAST—								
To Argentine Republic	266	15	397	158	2,836	236	4,117	2,173
„ Irish Free State	788	610	1,357	760	10,679	6,691	18,262	9,386
„ British South Africa	611	357	1,393	794	6,842	3,948	16,174	9,002
„ „ India	112	45	214	248	1,663	673	3,351	3,309
„ Straits Settlements and Malay States	189	37	876	191	1,627	397	7,986	1,745
Total (including other countries)	6,334	7,021	12,274	12,590	55,578	65,380	24,522	120,656
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	175	241	341	505	6,930	7,578	12,941	15,657
„ Enamelled	38	62	90	138	3,671	5,027	8,046	10,230
CASTINGS, in the rough—								
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